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ABSTRACT

This packet, part of the instructional materials for the Oregon apprenticeship program for millwright training, contains 16 modules covering drafting. The modules provide information on the following topics: types of drawing and views, sketching, blueprint reading/working drawings, working drawings for machines and welding, machine and welding symbols, basic blueprint reading and drafting, machine features for drafting, measurement, and visualization. Each module consists of a goal, performance indicators, student study guide, introduction, information sheets illustrated with line drawings and photographs, a self-assessment test with answers, and a post-assessment test. (KC)

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APPRENTICESHIP

MILLWRIGHT

RELATED TRAINING MODULES

5.1-5.16 DRAFTING

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APPRENTICESHIP

MILLWRIGHT
RELATED TRAINING MODULES

SAFETY

1.1 General Safety
1.2 Hand Tool Safety
1.3 Power Tool Safety
1.4 Fire Safety
1.5 Hygiene Safety
1.6 Safety and Electricity
1.7 Fire Types and Prevention
1.8 Machine Safeguarding (includes OSHA Handbook)

ELECTRICITY/ELECTRONICS

2.1 Basics of Energy
2.2 Atomic Theory
2.3 Electrical Conduction
2.4 Basics of Direct Current
2.5 Introduction to Circuits
2.6 Reading Scales
2.7 Using a V.O.M.
2.8 OHM'S Law
2.9 Power and Watt's Law
2.10 Kirchoff's Current Law
2.11 Kirchoff's Voltage Law
2.12 Series Resistive Circuits
2.13 Parallel Resistive Circuits
2.14 Series - Parallel Resistive Circuits
2.15 Switches and Relays
2.16 Basics of Alternating Currents
2.17 Magnetism

COMPUTERS

3.1 Digital Language
3.2 Digital Logic
3.3 Computer Overview
3.4 Computer Software

TOOLS

4.1 Boring and Drilling Tools
4.2 Cutting Tools, Files and Abrasives
4.3 Holding and Fastening Tools
4.4 Fastening Devices
4.5 Basic Science - Simple Mechanics
4.6 Fasteners

DRAFTING

5.1 Types of Drawing and Views
5.2 Sketching
5.3 Blueprint Reading/Working Drawings
5.4 Working Drawings for Machines and Welding
5.5 Machine and Welding Symbols
5.6 Blueprint Reading, Drafting: Basic Print Reading
5.7 Blueprint Reading, Drafting: Basic Print Reading
5.8 Blueprint Reading, Drafting: Basic Print Reading
5.9 Blueprint Reading, Drafting: Basic Print Reading
5.10 Blueprint Reading, Drafting: Basic Print Reading
5.11 Blueprint Reading, Drafting: Basic Print Reading
5.12 Blueprint Reading, Drafting: Basic Print Reading
5.13 Blueprint Reading, Drafting: Basic Print Reading
5.14 Drafting, Machine Features
5.15 Drafting, Measurement
5.16 Drafting, Visualization

HUMAN RELATIONS

6.1 Communications Skills
6.2 Feedback
6.3 Individual Strengths
6.4 Interpersonal Conflicts
6.5 Group Problem Solving
6.6 Goal-setting and Decision-making
6.7 Worksite Visits
6.8 Resumes
6.9 Interviews
6.10 Expectation
6.11 Wider Influences and Responsibilities
6.12 Personal Finance

BOILERS

7.1 Boilers - Fire Tube Types
7.2 Boilers - Watertube Types
7.3 Boilers - Construction
7.4 Boilers - Fittings
7.5 Boilers - Operation
7.6 Boilers - Cleaning
7.7 Boilers - Heat Recovery Systems
7.8 Boilers - Instruments and Controls
7.9 Boilers - Piping and Steam Traps

TURBINES

8.1 Steam Turbines - Types
8.2 Steam Turbines - Components
8.3 Steam Turbines - Auxillaries
8.4 Steam Turbines - Operation and Maintenance
8.5 Gas Turbines

PUMPS

9.1 Pumps - Types and Classification
9.2 Pumps - Applications
9.3 Pumps - Construction
9.4 Pumps - Calculating Heat and Flow
9.5 Pumps - Operation
9.6 Pumps - Monitoring and Troubleshooting
9.7 Pumps - Maintenance

COMBUSTION

10.1 Combustion - Process
10.2 Combustion - Types of Fuel
10.3 Combustion - Air and Fuel Gases
10.4 Combustion - Heat Transfer
10.5 Combustion - Wood

GENERATORS

11.1 Generators - Types and Construction
11.2 Generators - Operation

FEEDWATER

12.1 Feedwater - Types and Equipment
12.2 Feedwater - Water Treatments
12.3 Feedwater - Testing

AIR COMPRESSORS

13.1 Air Compressors - Types
13.2 Air Compressors - Operation and Maintenance

STEAM

14.1 Steam - Formation and Evaporation
14.2 Steam - Types
14.3 Steam - Transport
14.4 Steam - Purification

MISCELLANEOUS

15.1 Installation - Foundations
15.2 Installation - Alignment
15.3 Circuit Protection
15.4 Transformers
15.5 Trade Terms

TRADE MATH

16.1 Linear - Measure
16.2 Whole Numbers
16.3 Additional and Subtraction of Common Fraction and Mixed Numbers
16.4 Multiplication and Division of Common Fractions and Whole and Mixed Numbers

16.5 Compound Numbers
16.6 Percent
16.7 Ratio and Proportion
16.8 Perimeters, Areas and Volumes
16.9 Circumference and Wide Area of Circles
16.10 Area of Plane, Figures and Volumes of Solid Figures
16.11 Metrics

HYDRAULICS

17.1 Hydraulics - Lever
17.2 Hydraulics - Transmission of Force
17.3 Hydraulics - Symbols
17.4 Hydraulics - Basic Systems
17.5 Hydraulics - Pumps
17.6 Hydraulics - Pressure Relief Valve
17.7 Hydraulics - Reservoirs
17.8 Hydraulics - Directional Control Valve
17.9 Hydraulics - Cylinders
17.10 Hydraulics - Forces, Area, Pressure
17.11 Hydraulics - Conductors and Connectors
17.12 Hydraulics - Troubleshooting
17.13 Hydraulics - Maintenance

METALLURGY

18.1 Included are ILS packets:
W 3010
W 3011-1
W 3011-2
MS 9001 (1-3-4-8-9-6-7-5-2-9)
MS 9200, 9201

POWER DRIVES

19.1 101. A-B-C-D-E
102. C-D-E
103. B-C-D-E
104. A-C-E-F-G-H-I-J
107. A
108. A

WELDING

20.1 602. A-B-C-D-G-I-L-M
603. A-B-F-G-I
W. 3011-1 refer to Mettallurgy 18.1
WE. MA-18

MILLWRIGHT
SUPPLEMENTARY REFERENCE DIRECTORY

Note: All reference packets are numbered on the upper right-hand corner of the respective cover page.

Supplementary Packet #	Description	Related Training Module	
1.8	Concepts & Techniques of Machine Safeguarding, U.S.D.L., O.S.H.A.	1.8	Machine Safeguarding
12.1	Correspondence Course, Lecture 1, Sec. 2, Steam Generators, Types of Boilers I, S.A.I.T., Calgary, Alberta, Canada	7.1	Boilers, Fire Tube Type
12.2	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Types of Boikers II, S.A.I.T., Calgary, Alberta, Canada	7.2	Boilers, Water Tube Type
12.3	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Boiler Construction & Erection, S.A.I.T., Calgary, Alberta, Canada	7.3	Boilers, Construction
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fittings II, S.A.I.T., Calgary, Alberta, Canada	7.4	Boilers, Fittings
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fitting I, S.A.I.T., Calgary, Alberta, Canada	7.4	Boilers, Fittings
12.5	Correspondence Course, Lecture 10, Sec. 2, Steam Generation, Boiler Operation, Maintenance, Inspection, S.A.I.T., Calgary, Alberta, Canada	7.5	Boilers, Operation
12.7	Correspondence Course, Lecture 3, Sec. 2, Steam Generation, Boiler Details, S.A.I.T., Calgary, Alberta, Canada	7.7	Boilers Heat Recovery Systems
		PUMPS	
13.1	Correspondence Course, Lecture 9, Sec. 2, Steam Generator, Power Plant Pumps, S.A.I.T., Calgary, Alberta, Canada	9.1	Types & Classifications
13.2		9.2	Applications
13.4		9.4	Calculating Heat & Flow
13.6		9.6	Monitoring & Troubleshooting
13.7		9.7	Maintenance
13.3	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Pumps, S.A.I.T., Calgary, Alberta, Canada	9.3	Construction
13.5		9.5	Operation

Supplementary Packet #	Description	Related Training Module
14.3 12.8	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Steam Generator Controls, S.A.I.T., Calgary, Alberta, Canada	14.3 Steam Transport 7.8 Boilers, Instruments & Controls
14.4	Correspondence Course, Lecture 11, Sec. 2, Steam Generators, Piping II, S.A.I.T., Calgary, Alberta, Canada	14.4 Steam Purification
15.1	Correspondence Course, Lecture 1, Sec. 4, Prime Movers, & Auxiliaries, Steam Turbines, S.A.I.T., Calgary, Alberta, Canada	8.1 Steam Turbines, Types
15.2	Correspondence Course, Lecture 4, Sec. 3, Prime Movers, Steam Turbines I, S.A.I.T., Calgary, Alberta, Canada	8.2 Steam Turbines, Components
15.3	Correspondence Course, Lecture 2, Sec. 4, Prime Movers & Auxiliaries, Steam Turbine Auxiliaries, S.A.I.T., Calgary, Alberta, Canada	8.3 Steam Turbines, Auxiliaries
15.4	Correspondence Course, Lecture 6, Sec. 3, Prime Movers, Steam Turbine Operation & Maintenance, S.A.I.T., Calgary, Alberta, Canada	8.4 Steam Turbines, Operation & Maintenance
15.5	Correspondence Course, Lecture 8, Sec. 3, Prime Movers, Gas Turbines, S.A.I.T., Calgary, Alberta, Canada	8.5 Gas Turbines
16.2	Boilers Fired with Wood & Bark Residues, D.D. Junge, F.R.L., O.S.U., 1975	10.2 Combustion Types of Fuel
16.2	Correspondence Course, Lecture 5, Sec. 2, Steam Generators, Fuel Combustion, S.A.I.T., Calgary, Alberta, Canada	10.2 Combustion Types of Fuel
16.3	Correspondence Course, Lecture 5, Sec. 2, Plant Services, Fuel & Combustion, S.A.I.T., Calgary, Alberta, Canada	10.3 Combustion Air & Fuel Gases
17.1	Correspondence Course, Lecture 12, Sec. 3, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	12.1 Feedwater, Types & Operation
17.2	Correspondence Course, Lecture 12, Sec. 2, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	12.2 Feedwater, Water Treatments

Supplementary Packet #	Description	Related Training Module
17.3	Correspondence Course, Lecture 7, Sec. 2, Steam Generators, Boiler Feedwater Treatment, S.A.I.T., Calgary, Alberta, Canada	12.3 Feedwater, Testing
18.1	Correspondence Course, Lecture 2, Sec. 5, Electricity, Direct Current Machines, S.A.I.T., Calgary, Alberta, Canada	11.1 Generators, Types & Construction
18.1 18.2	Correspondence Course, Lecture 4, Sec. 5, Electricity, Alternating Current Generators, S.A.I.T., Calgary, Alberta, Canada	11.1 Generators, Types & Construction 18.2 Generators, Operation
19.1	Correspondence Course, Lecture 5, Sec. 4, Prime Movers & Auxiliaries, Air Compressor I, S.A.I.T., Calgary, Alberta, Canada	13.1 Air Compressors, Types
19.1	Correspondence Course, Lecture 6, Sec. 4, Prime Movers & Auxiliaries, Air Compressors II, S.A.I.T., Calgary, Alberta, Canada	13.1 Air Compressors, Types 13.2 Air Compressors, Operation & Maintenance
20.1	Basic Electronics, Power Transformers, EL-BE-51	15.4 Transformers
21.1	Correspondence Course, Lecture 6, Sec. 5, Electricity, Switchgear & Circuit, Protective Equipment, S.A.I.T., Calgary, Alberta, Canada	15.3 Circuit Protection
22.1	Correspondence Course, Lecture 10, Sec. 3, Prime Movers, Power Plant Erection & Installation, S.A.I.T., Calgary, Alberta, Canada	15.1 Installation Foundations

RECOMMENDATIONS FOR USING TRAINING MODULES

The following pages list modules and their corresponding numbers for this particular apprenticeship trade. As related training classroom hours vary for different reasons throughout the state, we recommend that the individual apprenticeship committees divide the total packets to fit their individual class schedules.

There are over 130 modules available. Apprentices can complete the whole set by the end of their indentured apprenticeships. Some apprentices may already have knowledge and skills that are covered in particular modules. In those cases, perhaps credit could be granted for those subjects, allowing apprentcies to advance to the remaining modules.

We suggest the the apprenticeship instructors assign the modules in numerical order to make this learning tool most effective.

SUPPLEMENTARY INFORMATION

ON CASSETTE TAPES

Tape 1: Fire Tube Boilers - Water Tube Boilers and Boiler Manholes and Safety Precautions

Tape 2: Boiler Fittings, Valves, Injectors, Pumps and Steam Traps

Tape 3: Combustion, Boiler Care and Heat Transfer and Feed Water Types

Tape 4: Boiler Safety and Steam Turbines

NOTE: The above cassette tapes are intended as additional reference material for the respective modules, as indicated, and not designated as a required assignment.

Modules 18.1, 19.1, and 20.1 have been omitted because they contain dated materials.

INDIVIDUALIZED LEARNING SYSTEMS

5.1

TYPES OF DRAWINGS AND VIEWS

Goal:

Upon completion of this module, the student will have a working knowledge of orthographic, pictorial and isometric drawings and types of lines, and will be able to identify them and understand how they are applied in reading blueprints.

Performance Indicators:

The student will complete a Self Assessment exam and a Post Assessment exam covering the topics, and will also complete an assignment consisting of six orthographic and isometric drawings.

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Study Guide

For successful completion of this module, complete the tasks in the order listed below. Check each one off as you complete it.

1. ____ Read the Goal and Performance Indicators on the cover of this module. This will explain what you can be expected to learn from the module and how you will demonstrate it.

2. ____ Read the Introduction section and study the Information section. In these sections you will acquire the knowledge necessary to pass the Self and Post Assessment exams.

3. ____ Complete the required assignments on the Assignment pages. Turn them in to your instructor for review.

4. ____ Complete the Self Assessment exam. This will show how well you can expect to do on the Post Assessment exam. Compare your answers with those on the Self Assessment Answer Sheet found immediately following the exam. If you scored poorly, re-study the Information section or ask your instructor for help.

5. ____ Complete the Post Assessment exam. Turn the answers in to your instructor. It is recommended you score 90% or better before continuing with the next module.

Introduction

One of the problems in all drawing is how to depict a three-dimensionsal cbject on a two-dimensional sheet of paper. Any attempt at showing all three dimensions on a single drawing will result in foreshortened lines that will not represent true dimensions of the object. To show an object's true shape, the draftsperson must make two or more related drawings, each of which depicts the object in two of its principal dimensions only--width and depth, width and height, or height and depth. Almost without exception, working drawings are made this way.

Sometimes, however, it is desirable to portray the object more nearly as an observer would normally see it--that is, to show all three principal dimensions at once. Several methods are employed for making drawings of this picture-like type, and all are useful for illustrating the overall shape and general features of technical objects. However, all of these pictorial drawing methods have a common disadvantage that makes them generally unsuitable for the production of working drawings: the true measurements of the object.

Information

ORTOHOGRAPHIC PROJECTION

The drawing method almost universally employed in the making of architectural and engineering working drawings is called orthographic projection; the drawings produced in this way are called orthographic or "true" drawings, as opposed to the picture-like drawings made by pictorial drawing methods. Unlike most pictorial drawings, orthographic drawings are drawn to scale, and true measurements can be taken from them.

An orthographic view shows one face or side of an object to the extent that it would be seen by an observer looking squarely at that side or face. No pictorial techniques are employed for an orthographic drawing, the object being shown in its actual form, not is apparent form. This makes it possible for the draftsperson to indicate, in a series of related orthographic views, the true size, shape, and location of every part of the object and to present dimensions in a clear and precise way.

VISUALIZING THE OBJECT FROM ORTHOGRAPHIC WORKING DRAWINGS

The orthographic-projection drawing method (also called "three-view" or "multiview" drawing) can best be understood from a study of the three most common orthographic views--top, front, and side views--as they are employed in mechanical drawings to represent a simple object, as for example in Fig. F-13.

Each of the three orthographic viewsin Fig. F-13 reveals the shape of the object as perceived from a particular viewing direction. Collectively, the three views provide a complete illustration of the object. The top view shows it in width and depth. The front view, which is obtained by rotating the object 90^{0} on its vertical axis away from the front view, shows it in height and depth. If additional orthographic views are required to complete the description of an object, they will be developed by further 90^{0} rotations, and thus will will bear right-angle relationships to the

top, front, and side views. Front, side, and rear views are called elevations. Hidden features are indicated on orthographic drawings by means of dotted lines, as in the front and side views in Fig. F-14.

In an orthographic drawing, only those object lines that are perpendicular to the observer's direction of view--that is, parallel with the picture plane--are shown in their true scale length. The oblique line A-B is drawn in true proportion in the top view in Fig. F-15. In the front view, however, the line A-B is drawn shorter than its true scale length and therefore is not shown in true proportion.

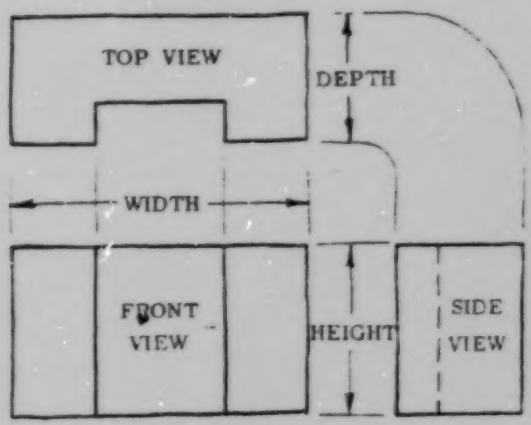


Fig. F 13
Orthographic (multiview) projections

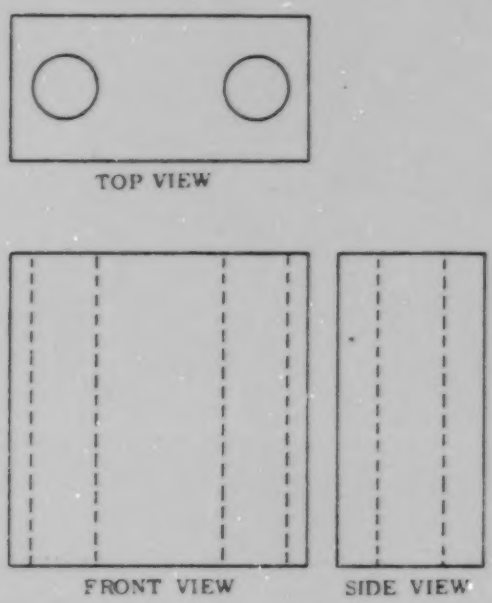


Fig. F-14
Hidden lines in orthographic views

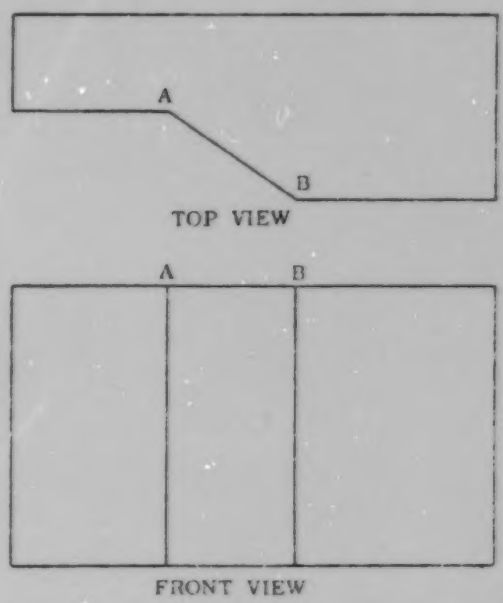


Fig. F-15
Oblique lines in orthographic projection

From this discussion, it will be seen that the shape of an object cannot be visualized from a single orthographic view; all the related views must be studied together. The importance of this rule will become apparent as more complex working drawings are encountered.

TYPES OF LINES IN WORKING DRAWINGS

Several types of lines, each having a specific meaning, are employed in the making of working drawings; some lines are thicker than others, some are solid, and some are broken. Some of the more common types of lines with an example of their application, are shown in Fig. F-16. Such a listing of conventional drafting lines is called an "alphabet of lines."

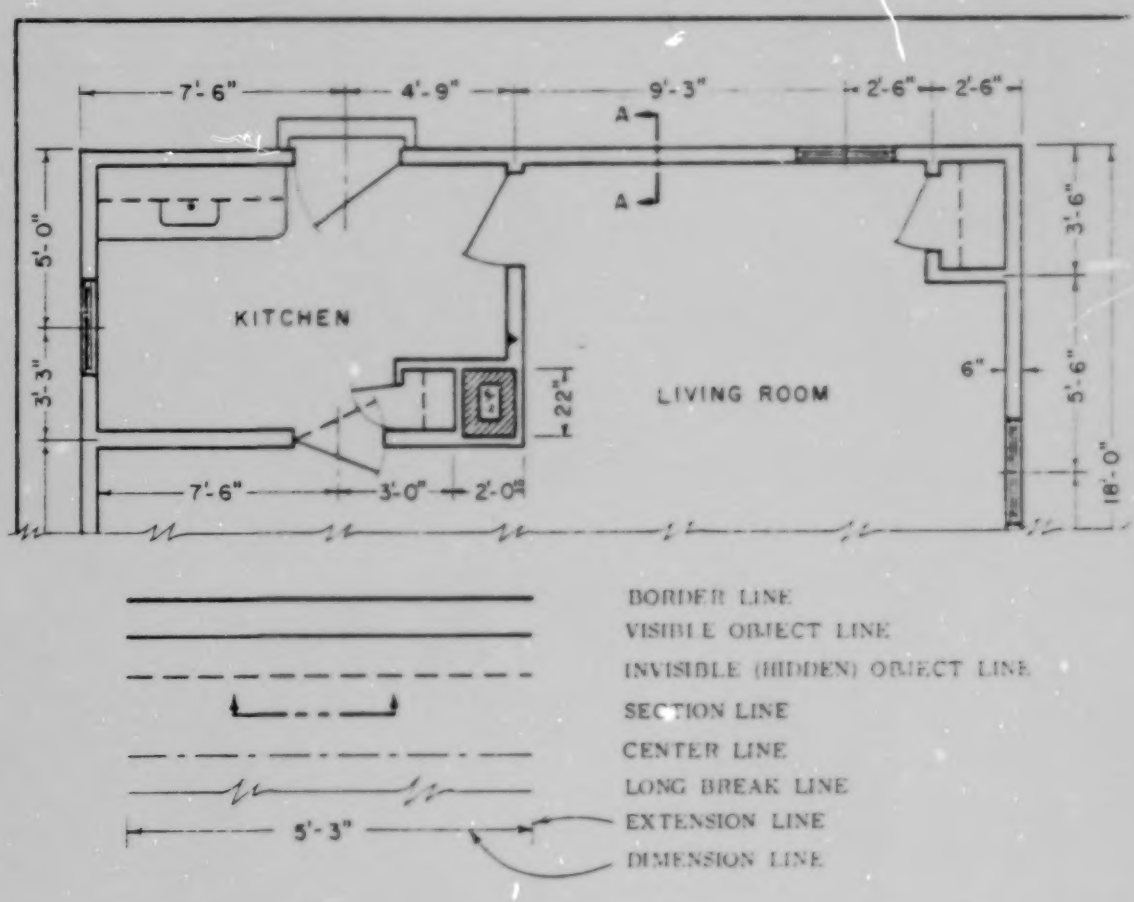


Fig. F-16. Lines used in working drawings.

PICTORIAL DRAWINGS

Because a pictorial drawing shows more than one face of the object, it can give more information about the shape of the object than would be possible with any single orthographic view. For this reason, persons without technical training find pictorial drawings the easier type to understand. The main disadvantage of pictorial drawings lies in their distortion of true object lines and angles; this makes them unsatisfactory for describing complete and detailed forms. However, they are useful in cases where the measurements of the image need not correspond exactly with those of the actual object. For example, the architect uses a pictorial drawing to show his or her client how the house will look when completed.

The two principal types of pictorial drawings are perspective and axonometric drawings. A third type, the oblique drawing, is partly axonometric and partly orthographic. Because of the distorted appearance of objects drawn by the oblique method, it is not widely used for pictorial representation and will not be discussed further here.

PERSPECTIVE DRAWINGS

The type of pictorial drawing that represents an object most clearly as it is seen by the human eye is the perspective drawing. The optical line relationships in a perspective drawing are like those in a photograph; that is, all lines that are parallel on the actual object tend to converge at some distant point on the drawing.

Perspective drawings are seldom used as working drawings; they are used mainly in sales and promotion work and as architectural "presentation" drawings.

AXONOMETRIC DRAWINGS

The term "axonometric" refers to the class of pictorial drawings in which all the measurements necessary for making the drawing are made on the three principal axes of the object or on lines parallel with those axes. A rectangular solid drawing in this way consists of three sets of lines, each set being parallel to one of the principal axes, and reveals three of its faces. An infinite number of axonometric positions is possible, the choice of position depending upon how the object is to be viewed. (See Fig. F-17.) The isometric position, second from the right in the illustration, is the one most often employed. An axonometric drawing in the isometric position is called an isometric drawing.

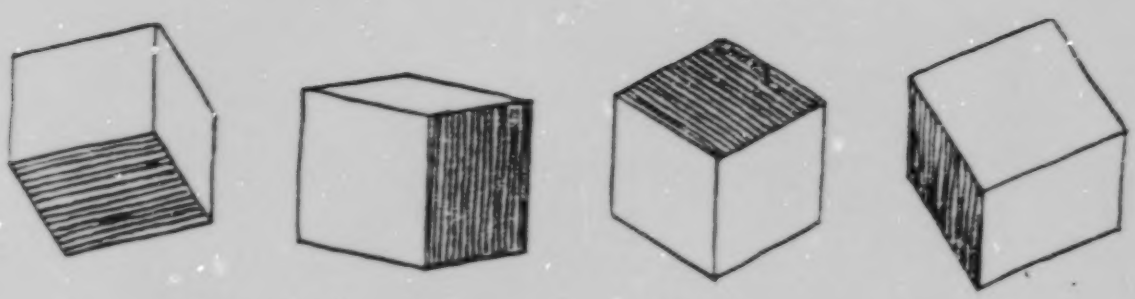


Fig. F-17. Axonometric drawings in several positions

THE THEORY OF ISOMETRIC DRAWING

The Theory of isometric drawing is that the object is viewed from the exact position in which three of its sides are seen equally foreshortened. In making an isometric drawing, the draftsperson first lays out the three isometric axes--one vertical and other two tipped up 30° from a horizontal base line, as shown in Fig. F-18. The height, width, and depth of the object are measured off on these axis lines. Since all lines on or parallel with the isometric axes are foreshortended equally, they will be in true proportion; however, they will never appear as true scale lengths, as do the lines in orthographic drawings. The relationship of an isometric view and three orthographic views of an object is shown in Fig. F-19.

ANGLES IN ISOMETRIC DRAWINGS

Angles cannot be directly transferred from orthographic drawings to isometric drawings; this is so because angles do not appear in their true shape in isometric drawings. To transfer angles in making an isometric drawing from orthographic views, the draftsperson first transfers the intersection points of the lines that form the angles, then draws the angles from the transferred points. (See Fig. F-20.)

CURVES IN ISOMETRIC DRAWINGS

Like angles, curves suffer distortion in being transferred from orthographic drawings to isometric drawings. To transfer a curve, the draftsperson first plots points on the isometric drawing from similar locations along the curve on the orthographic drawing, then connects the points with a curved line. (See Figs. F-21 and F-22.) To simplify transferring the points, he or she may lay out a grid of rectangular coordinates on the multiview drawing and a corresponding isometric grid on the sheet for the isometric drawing.

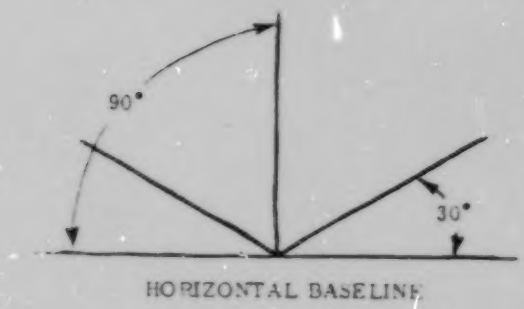


Fig. F-18. Layout of isometric axes

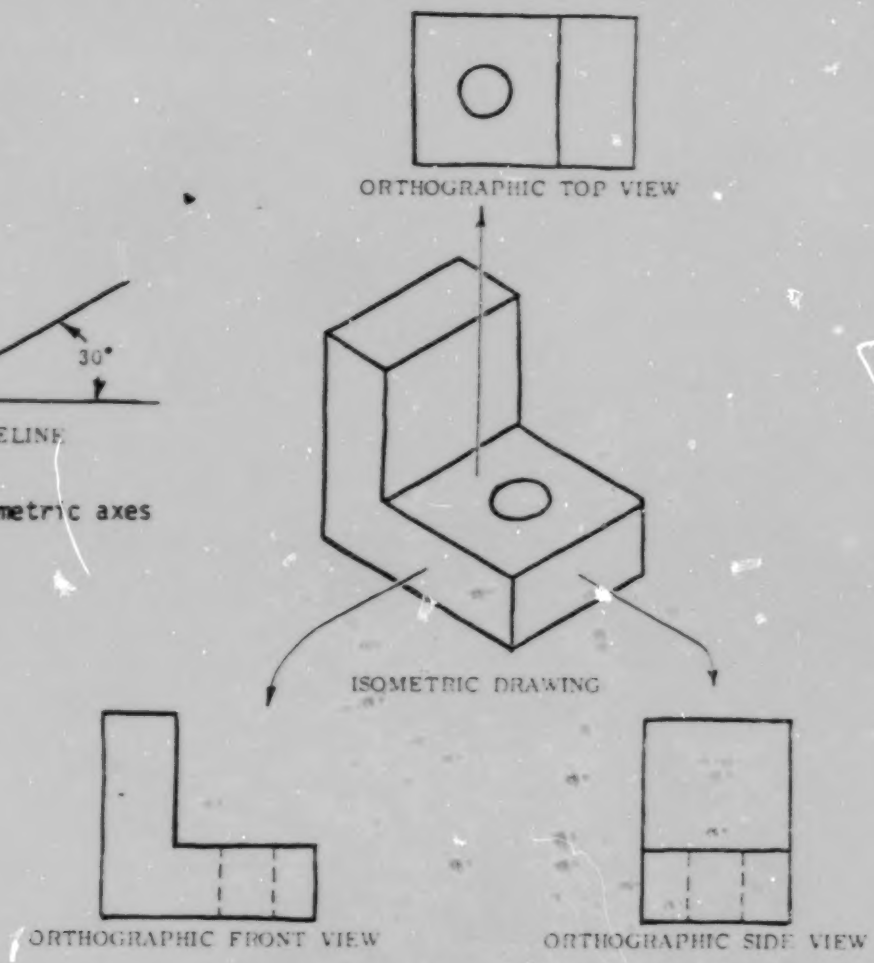


Fig. F-19

Isometric drawing and orthographic views of an object

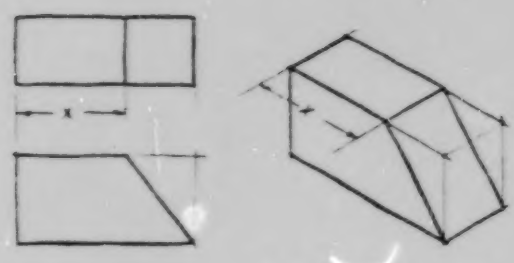


Fig. F-20

Orthographic projection and isometric drawing of an object with an angled surface

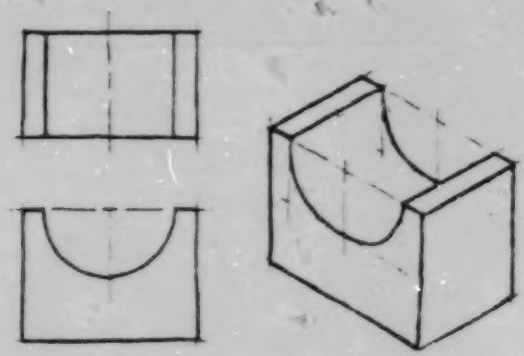


Fig. F-21

Orthographic projection and isometric drawing of an object with a curved surface

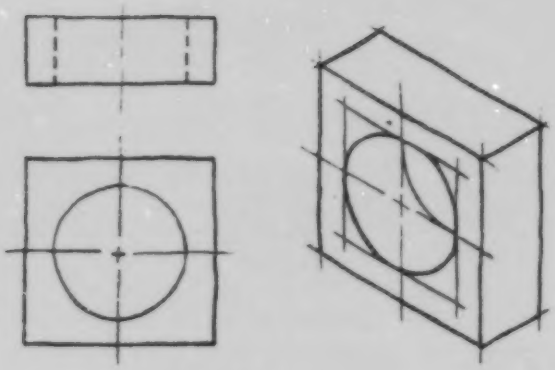
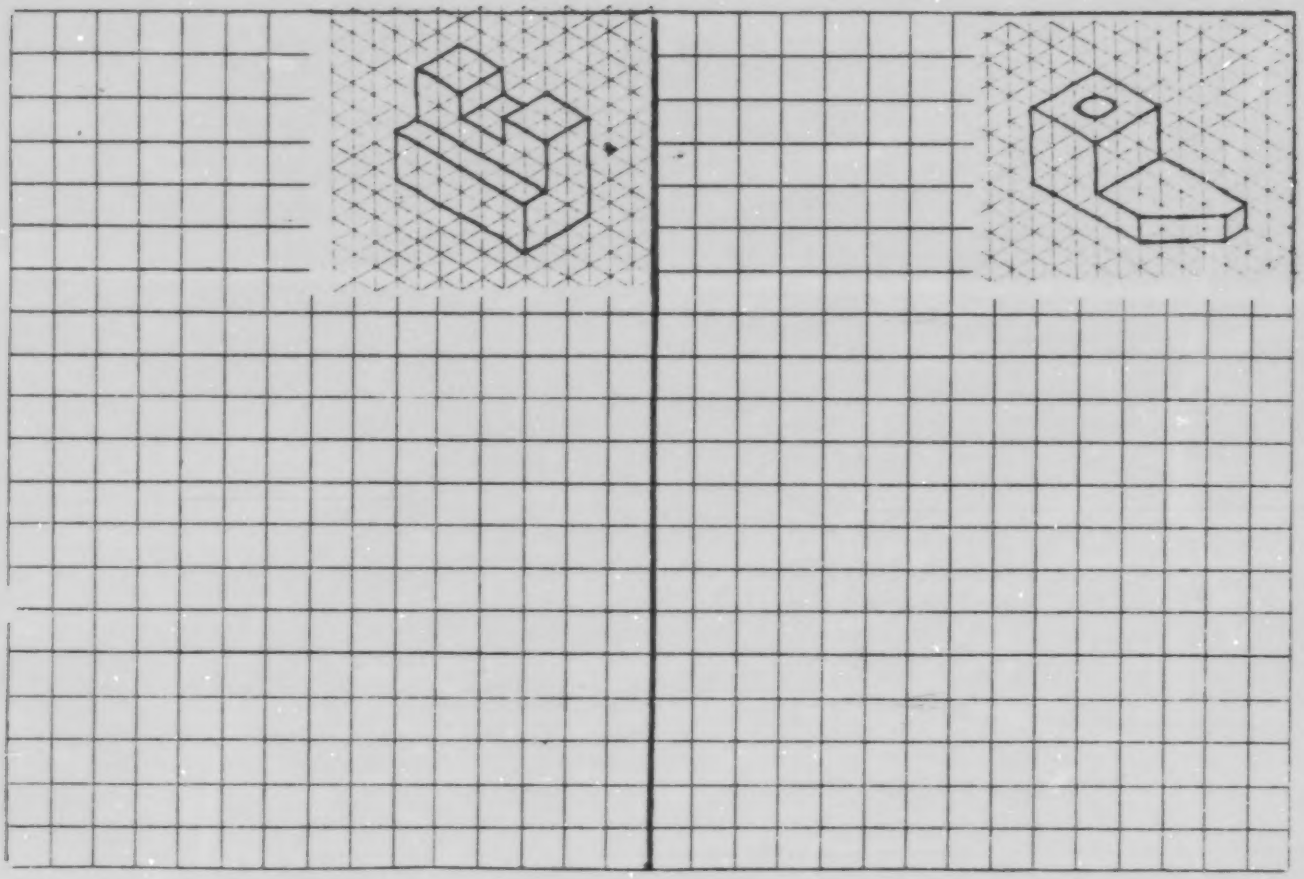


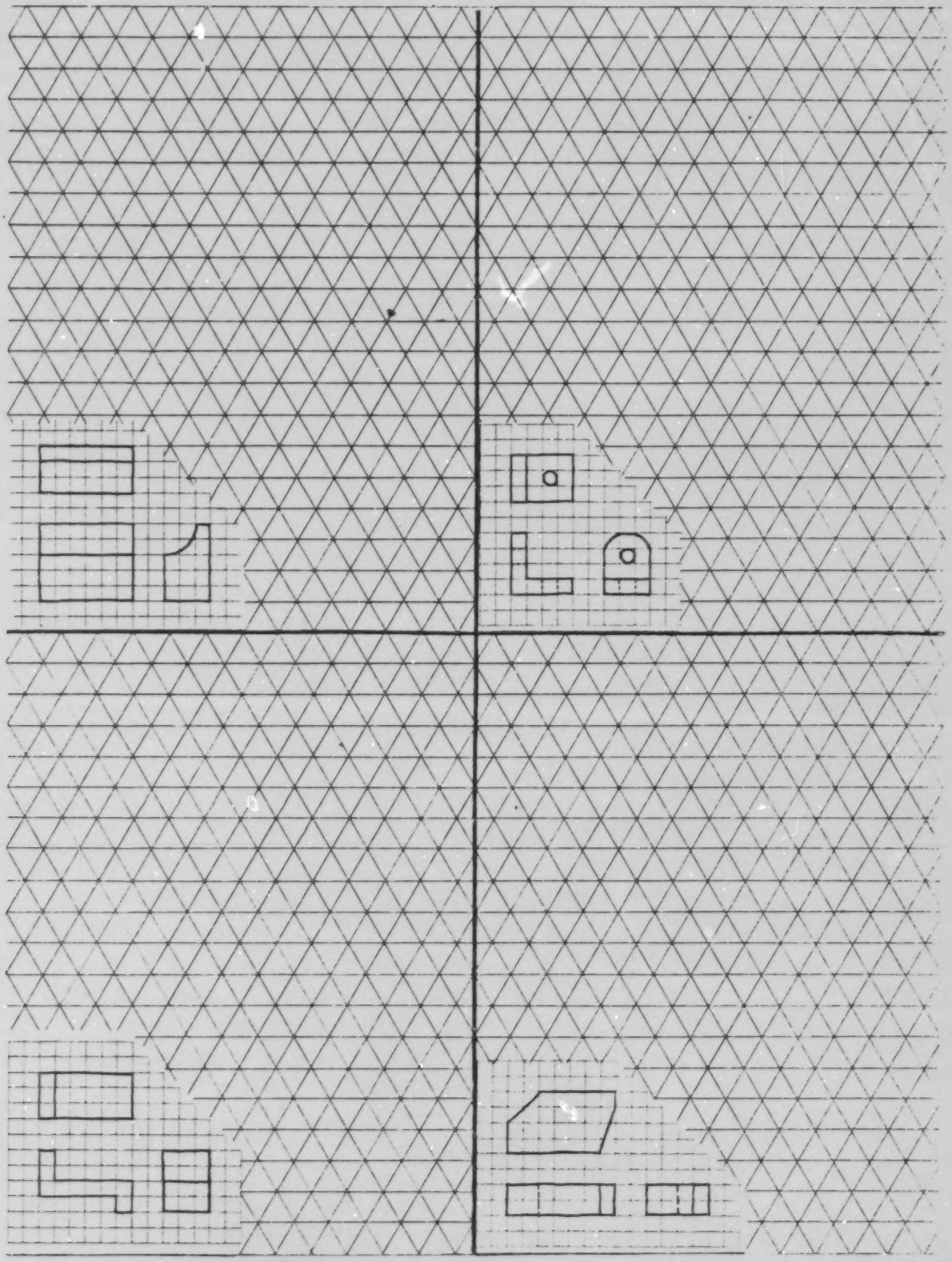
Fig. F-22

Orthographic projection and isometric drawing of an object with a center hole

Assignment

In each of the two rectangular grids on this page, sketch the top, front, and right side views of the object shown in the small isometric drawing. In each of the four isometric grids on the following page, make isometric sketches of the object shown in the small multiview drawing.





Self Assessment

After you have studied the material in the module, complete the exercises by writing in the word that belongs in each space.

1. The drawing method used for making most working drawings is called _____.

2. Orthographic drawings are drawn to _____ and _____ measurements can be taken from them.

3. An orthographic view shows only one _____ or _____ of an object.

4. In architectural drawings, a view from above is called a(n) _____ view.

5. A listing of conventional drafting lines used in the making of a working drawing is called a(n) _____ of _____.

6. The type of drawing that represents an object most nearly as it would be seen in a photograph is a(n) _____ drawing.

7. A pictorial drawing shows more than one _____ of an object.

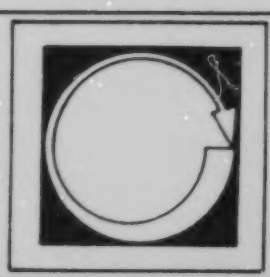
8. The type of pictorial drawing in which all of the principal axes are equally foreshortended is the axonometric drawing.

9. In an isometric drawing, two of the three principal axes are tipped up _____ degrees from the horizontal; the third axis is _____.

SELF ASSESSMENT ANSWER SHEET

1. orthographic projection
2. scale, true
3. face, side
4. top
5. alphabet, lines
6. pictorial
7. view
8. axonometric
9. 30^{o}, 90^{o}

Post Assessment



Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

1. ____ The drawing method almost universally employed for making working drawings is called:

   a. orthographic projection
   b. isometric projection
   c. perspective drawing
   d. scaling

2. ____ One disadvantage of pictorial drawings is that in general they:

   a. are too large for use on the job
   b. are suitable only for exterior views
   c. do not accurately represent object lines and angles
   d. give a poor overall view of an object

3. ____ An isometric drawing is one kind of:

   a. orthographic drawing
   b. perspective drawing
   c. axonometric drawing
   d. multiview drawing

4. ____ An orthographic view shows how many sides or faces of an object?

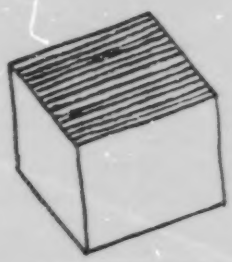
   a. one
   b. two
   c. three
   d. four

5. ____ The true shape of an object cannot be visualized from a single:

   a. orthographic view
   b. perspective view
   c. pictorial view
   d. axonometric view

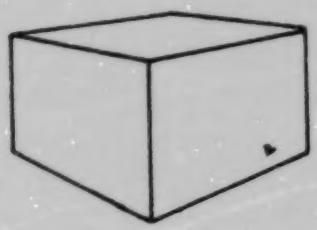
6. ____ The drawing shown below is properly called:

   a. pictorial
   b. orthographic
   c. multiview
   d. isometric



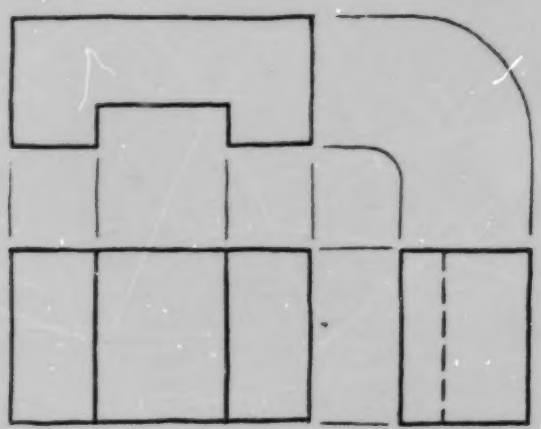
7. ____ The drawing shown below is properly called:

a. perspective
b. isometric
c. axonometric
d. orthographic



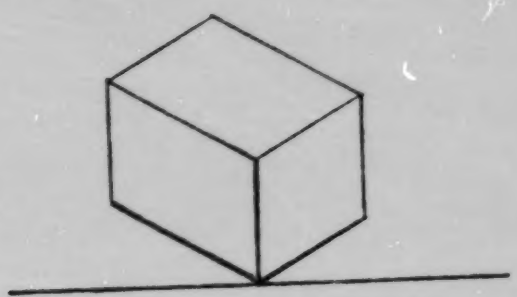
8. ____ The drawing shown below is properly called:

a. pictorial
b. perspective
c. axonometric
d. orthographic



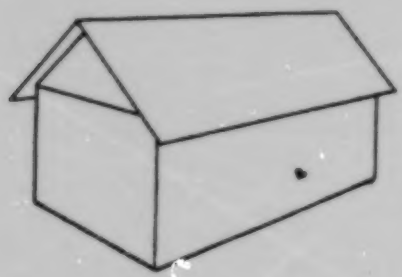
9. ____ The drawing shown below is properly called:

a. multiview
b. orthographic
c. oblique
d. isometric



10. ____ The drawing shown below is properly called:

a. pictorial
b. multiview
c. isometric
d. orthographic



INDIVIDUALIZED LEARNING SYSTEMS

5.2

SKETCHING

Goal:

The student will learn the elements of and reasons for sketching as an essential aid to understanding blueprints.

Performance Indicators:

The student will successfully complete a Self Assessment and a Post Assessment exam and will make assigned free-handed sketches.

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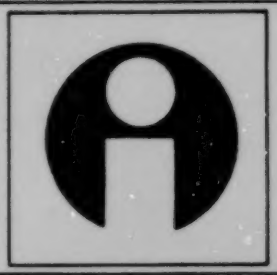
Study Guide



For successful completion of this module, complete the tasks in the order listed below. Check each one off as you complete it.

1. ____ Read the Goal and Performance Indicators on the cover of this module. This will explain what you can be expected to learn from the module and how you will demonstrate it.

2. ____ Read the Introduction section and study the Information section. In these sections you will acquire the knowledge necessary to pass the Self and Post Assessment exams.

3. ____ Complete the Self Assessment exam. This will show how well you can expect to do on the Post Assessment exam. Compare your answers with those on the Self Assessment Answer Sheet found immediately following the exam. If you scored poorly, re-study the Information section or ask your instructor for help.

4. ____ Complete the Post Assessment exam. Turn the answers in to your instructor. It is recommended you score 90% or better before continuing with the next module.

Introduction

For the skilled worker, the importance of being able to make quick, clear and accurate sketches cannot be overemphasized. Most mechanical and architectural ideas are expressed better by means of a sketch than by a verbal description. In general, once a technical problem has been put down as a picture, it is more clearly defined and its complications become more obvious. In some instances, sketches may take the place of regular working drawings; for example, a shop sketch made by the foreman or a journeyman may be the only drawing for a small job that is to be done in the shop.

In learning to sketch, the apprentice will not only acquire a needed job skill; he or she will also develop the ability to observe things more critically. Making an accurate sketch of an object requires that all its details and parts relationships be carefully studied and clearly understood.

Information

USES OF SKETCHES

The degree of perfection and the amount of detail required in a given sketch depends upon its intended use. Sketches made to organize ideas, or to develop or formulate various solutions to a given problem, may be rough or incomplete. An architect's quickly drawn preliminary floor plan, showing his or her ideas for room arrangement, is a good example of such a rough sketch. On the other hand, sketches intended for communicating important information in a precise way should be very carefully done. An example of this would be a detail sketch developed from an existing drawing, possibly to show necessary changes in construction or to give detailed information about size, materials, and installation.

MATERIALS FOR SKETCHING

The materials required for making sketches are few--usually only a pencil, some paper, and an eraser. The pencil should have a rather soft lead--a No. 2 in the ordinary pencil series or an HB or F in the drafting pencil series. End views of various drafting pencils, ranging from the very hard 9G to the very soft 7B, are illustrated in Fig. F-8. The harder drafting pencils are used where high accuracy is required; medium pencils are used for general sketching and lettering; and the softer pencils are used for making large freehand drawings. (Coordinate paper, which has crossed lines or grids, is helpful to the beginner; the grids may be used as guides for drawing lines and keeping proportions. The grids of such paper are either rectangular or isometric. (See Fig. F-9.)

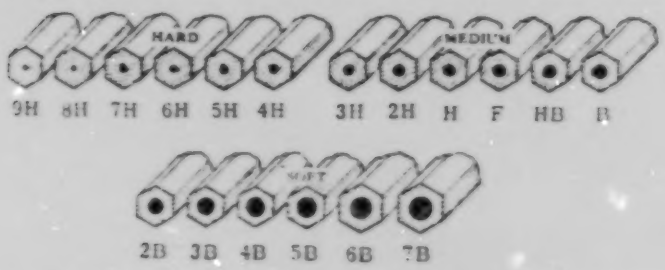


Fig. F-8. Hard, medium & soft drafting pencils

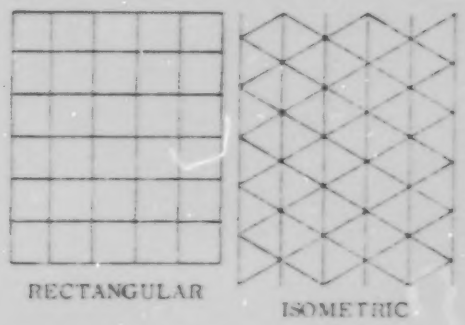


Fig. F-9. Grids of coordinate paper

SIZE AND PROPORTIONS OF SKETCHES

In general, sketches are not made to any scale, but they should be as nearly in proportion as possible. Before a sketch can be started, the overall dimensions of the object to be drawn must be known; the size of the sketch can then be planned in accordance with the area available for it on the paper. When the desired size for the sketch has been determined, the proportions can be worked out from the dimensions of the object. In working out proportions, it is helpful to ask oneself questions like these: How many times greater is the height than the width (or vice-versa) of the object? If the object has openings, are their height and width greater then the spaces between them?

SKETCHING PROCEDURES AND TECHNIQUES

The term "sketch" is often misunderstood to mean a vague, crude drawing; however; if even a rough sketch is to be of any value, it must be done with reasonable care and accuracy. Speed in sketching is desirable, but the beginner should concentrate at first on developing accuracy. He or she should hold the pencil in the normal writing position, using wrist motion for sketching the shorter lines and forearm motion for the longer ones. All lines should be drawn with a free movement, without hesitation, and fairly fast.

SKETCHING LINES

A group of exercises designed to develop skill in the sketching of lines is given on the next page. In doing these exercises, the apprentice should connect the dots in each set as shown, making each line with one firm, quick stroke and keeping his or her eye on the dot toward which the pencil is moving--not on the pencil point. Short, "hairy" strokes must be avoided; the pencil should be kept in contact with the paper for the entire length of the stroke. If the resulting line looks wavy, it was probably drawn too slowly; if the line misses the dots, it was probably drawn too fast. It is good practice to go through the motion of the stroke once or twice with the pencil raised slightly off the paper before actually drawing the line; when the stroke seems to be going where it should, the pencil point can be lowered onto the paper and the final stroke made.

EXERCISES IN SKETCHING LINES

HORIZONTAL

VERTICAL

DIAGONAL

DIAGONAL

CURVED

BASIC FORMS IN SKETCHING

When you have become proficient in the freehand drawing of lines, you will be ready to try sketching the basic geometric forms--squares, rectangles, triangles, and circles--that singly or in various combinations represent the shapes of most objects.

Two simple ways to sketch rectangles or squares when the lines are parallel to the paper edge are shown in Fig. F-10. In the method illustrated at the left, points are laid out the required distance in from the paper edges, then connected with freehand pencil strokes. A strip of paper or cardboard can be marked and used as a gage for laying out the points. The method illustrated at the right can be employed if a sketching pad is being used; the pencil is held as shown, the fingertips being used to guide the hand along the edge of the pad.

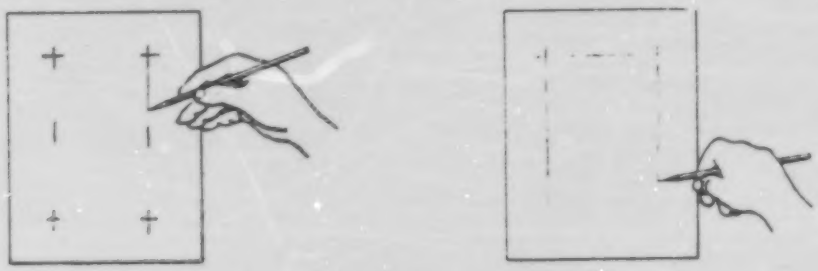


Fig. F-10. Two methods of sketching lines parallel to the paper edge

The sketching of squares, rectangles, triangles, and circles is made easier by laying them out on crosses (intersecting lines) that have been marked to provide reference points for the drawing. (See Fig. F-11.)

Circles and arcs, especially the larger ones, may also be drawn with fair accuracy by placing the tip of the little finger on the paper where the center of the circle will come, holding the pencil steady and with moderate pressure on the paper, then rotating the paper carefully. (See Fig. F-12.)

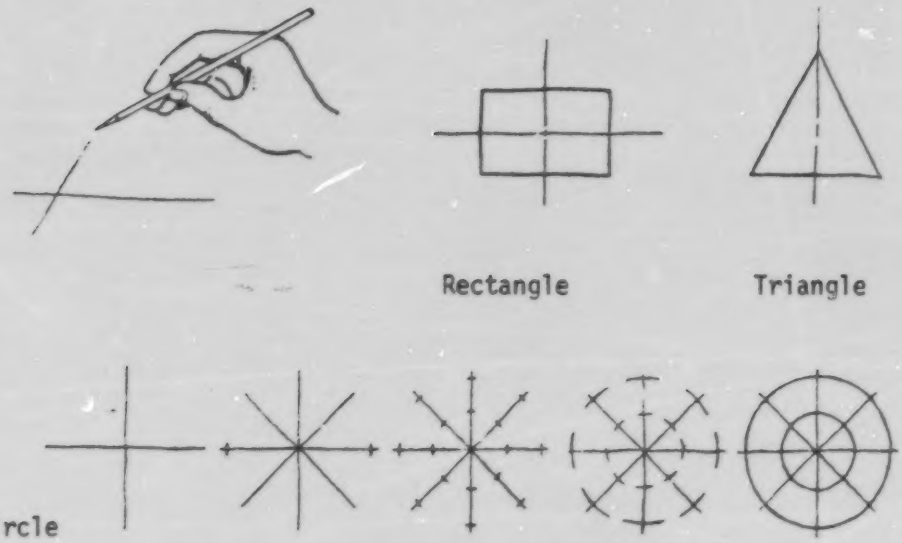


Fig. F-11. Laying out figures from center lines

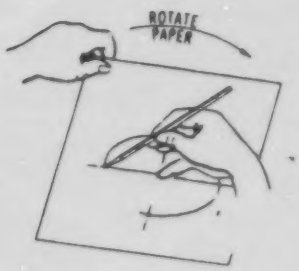


Fig. F-12. Another method of drawing a circle

Self Assessment

Read each statement and decide whether it is true or false. Write T if the statement is true; write F is the statement is false.

1. ____ Sketching an object may compel a person to change his or her opinion of it in some way.

2. ____ A sketch developed from an existing drawing to show a change in construction should be very carefully done.

3. ____ To make a good-quality line for a sketch, one should use short, overlapping pencil strokes.

4. ____ Sketches are usually made to some given scale.

5. ____ Lines are employed in sketching to represent the surfaces, edges, and contours of objects.

6. ____ Most right-handed persons find that the most natural direction for drawing horizontal lines is from left to right.

7. ____ A ruler is an essential instrument in freehand sketching.

8. ____ If the lines of a sketch are wavy, they were probably drawn too fast.

SELF ASSESSMENT ANSWER SHEET

1. T

2. T

3. F

4. T

5. T

6. T

7. F

8. F

Post Assessment

Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

1. ____ Learning to sketch develops a technical student's ability to:

   a. use drafting instruments
   b. understand verbal instructions
   c. observe things critically
   d. use the tools of his or her trade

2. ____ Which of the following combinations of materials would be best for the beginner in sketching?

   a. coordinate paper
   b. charcoal and wood
   c. unlined paper and any soft pencil having an eraser
   d. typing paper, typewriter eraser, and HB drafting pencil

3. ____ In drawing a line freehand, one should use:

   a. a series of short, overlapping strokes
   b. a straightedge if the line is over 4" long
   c. wrist motion only
   d. a single pencil stroke

4. ____ The first step in learning to sketch is to practice drawing:

   a. lines
   b. rectangles
   c. planes and contours
   d. three-dimensional forms

5. ____ Coordinate tracing paper has:

   a. no lines
   b. vertical lines only
   c. horizontal lines only
   d. crossed lines or grids

6. ____ Sketches are usually made:

   a. to scale and in proportion
   b. to scale but not in proportion
   c. neither to scale nor in proportion
   d. in proportion but not to scale

7. ____ The first step in making a sketch is to:

   a. draw the lines representing the top and bottom of the object
   b. draw the lines representing the sides of the object
   c. determine the overall dimensions of the object
   d. determine all the dimensions of the object

8. ____ The degree of perfection and the amount of detail required in a sketch depends upon the:

   a. number of copies to be made
   b. importance of the information given in the sketch
   c. time available for sketching
   d. cost of the item being sketched

9. ____ Which one of the following is essential equipment for sketching?

   a. drafting instruments
   b. coordinate paper
   c. blueprint machine
   d. soft eraser

10. ____ If a freehand-drawn line looks wavy, it probably was drawn:

   a. with too soft a pencil
   b. one the wrong paper
   c. too rapidly
   d. too slowly

INDIVIDUALIZED LEARNING SYSTEMS

5.3

BLUEPRINT READING
WORKING DRAWINGS

Goal:

The student will become familiar with the types of information, general and detailed, which may be found on working drawings.

Performance Indicators:

The student will refer to a set of working drawings to complete a Self Assessment and a Post Assessment exam.

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Study Guide

For successful completion of this module, complete the tasks in the order listed below. Check each one off as you complete it.

1. ___ Read the Goal and Performance Indicators on the cover of this module. This will explain what you can be expected to learn from the module and how you will demonstrate it.

2. ___ Read the Introduction section and study the Information section. In these sections you will acquire the knowledge necessary to pass the Self and Post Assessment exams.

3. ___ Complete the Self Assessment exam. This will show you how well you can expect to do on the Post Assessment exam. Compare your answers with those on the Self Assessment Answer Sheet found immediately following the exam. If you scored poorly, re-study the Information section or ask your instructor for help.

4. ___ Complete the Post Assessment exam. Turn the answers in to your instructor. It is recommended you score 90% or better before continuing with the next module.

Introduction

Anyone entering any of today's trades or technical fields must have a thorough knowledge of the graphic language of blueprints. Learning this special language, like learning any other, demands careful and patient study of its theory and composition, its symbols, and its conventions. With practice, the apprentice will be able to read the new language without difficulty and employ it, through sketching, to express his or her technical ideas to others. As you acquire skill in blueprint reading, you will be able to visualize from its drawings how a technical object will look when completed and how its parts will fit together. The apprentice will also be able to determine from a study of the drawings what machines, equipment, and work processes will be needed to construct, erect, or install the object.

Working drawings--architectural or engineering drawings reproduced as blueprints--can be considered to be tools of every technical occupation. A skilled worker in any of the building trades, for example, must know how to get information from a set of working drawings quickly and accurately. To do this, the worker must be able to visualize the object from the line drawings on the blueprints. The worker must also understand the meanings of symbols and conventions, which are the "shorthand" means used by the draftsperson to indicate materials, quantities, sizes, locations, and details of construction. When necessary, the worker must be able to get from written specifications information regarding the quality of materials, finish, and workmanship agreed upon by the contractor and the client.

Information

Many present-day buildings are very complex, and the complete set of working drawings for such a building usually includes separate sheets of drawings for the several crafts--structural, plumbing, heating and ventilating, electrical, and so forth--in addition to the usual architectural drawings. Although each worker will be primarily concerned with the working drawings for his or her own trade, he or she may also need to refer to other drawings in the complete set from time to time.

A set of working drawings, reduced in size, is included at the end of this module to illustrate the discussion that follows. The apprentice should study all the drawings carefully to get a clear idea of the kinds of information each provides about the construction project (a one-room elementary school). Reading working drawings like these is part of the day-to-day work of every skilled craftsworker in the building industry.

SITE DEVELOPMENT PLAN (SHEET 1)

The first drawing to be considered in a set of blueprints for a construction project is usually the site development plan or plot plan, which may also incorporate an area map and a site grading plan. Plot plans include the following essential information that must be known before any building can be erected: compass directions, property lines, contours (slopes), location of the building or buildings on the site, and locations of roads, trees, existing structures, and utilities. Approaches to the buildings and finished grade contours are also shown.

FOUNDATION PLAN (SHEET 2)

The foundation plan for a building shows the overall dimensions of the foundation walls and includes cross sections that show the width, depth, and the height of the footings at various locations. It also indicates the placement and sizes of steel reinforcing rods and anchor bolts and the location and dimensions (including thickness) of all concrete floor slabs and steps.

FLOOR PLAN (SHEET 3)

A floor plan shows the layout of a single floor of a building. It is in effect the view from above that would be revealed if the building were sliced through horizontally at a height that would best show interior features. The floor plan shows the arrangement, size, and shape of the rooms; the thickness of walls and partitions; the location of windows, doors, and other wall openings; and the size, shape, and location of plumbing fixtures and other mechanical fixtures.

Symbols are employed to represent mechanical features and details where this results in the simplification or clarification of the floor plan. The apprentice should give careful attention to the various uses made of symbols not only on the floor plan but on all the other working drawings of this set as well. If the meaning of a symbol, a term, or an abbreviation on the drawing is not clear, he or she should ask the instructor to explain it.

EXTERIOR ELEVATIONS (SHEET 3)

An exterior elevation is a view of one side or the front or back of a structure, showing its shape, the size and location of openings, and other features as roof details and exterior finishes.

INTERIOR AND SECTIONAL ELEVATIONS (SHEETS 5 AND 6)

Interior elevations show the placement and relationship of interior parts of the building. Sectional elevations are detailed interior elevations that represent the building, or some part of it, as if it were sliced through vertically. Many interior and sectional drawings may be needed to provide all the essential information about such items as wall construction, joinery, and interior openings in a complex structure.

DETAIL DRAWINGS (SHEETS 4 AND 7)

When a construction detail is shown with insufficient clarity or completeness in a floor plan, elevation, or other small-scale drawing, the detail is presented elsewhere drawn to a larger scale. The detail drawing is keyed to the smaller-scale drawing by means by an identifying number or letter.

SHOP DRAWINGS

Shop drawings are an exception to the general rule that the architect or engineer

shall provide all the working drawings needed for bringing the construction project to completion. (No examples of shop drawings are included in this module.) A shop drawing is a blueprint that may be supplied by a manufacturer of special equipment--commercial cabinets and fixtures, for example--to show how the equipment is constructed and how it should be installed. Shop drawings must have the approval of the architect or engineer.

NOTES AND SCHEDULES (SHEETS 3 and 4)

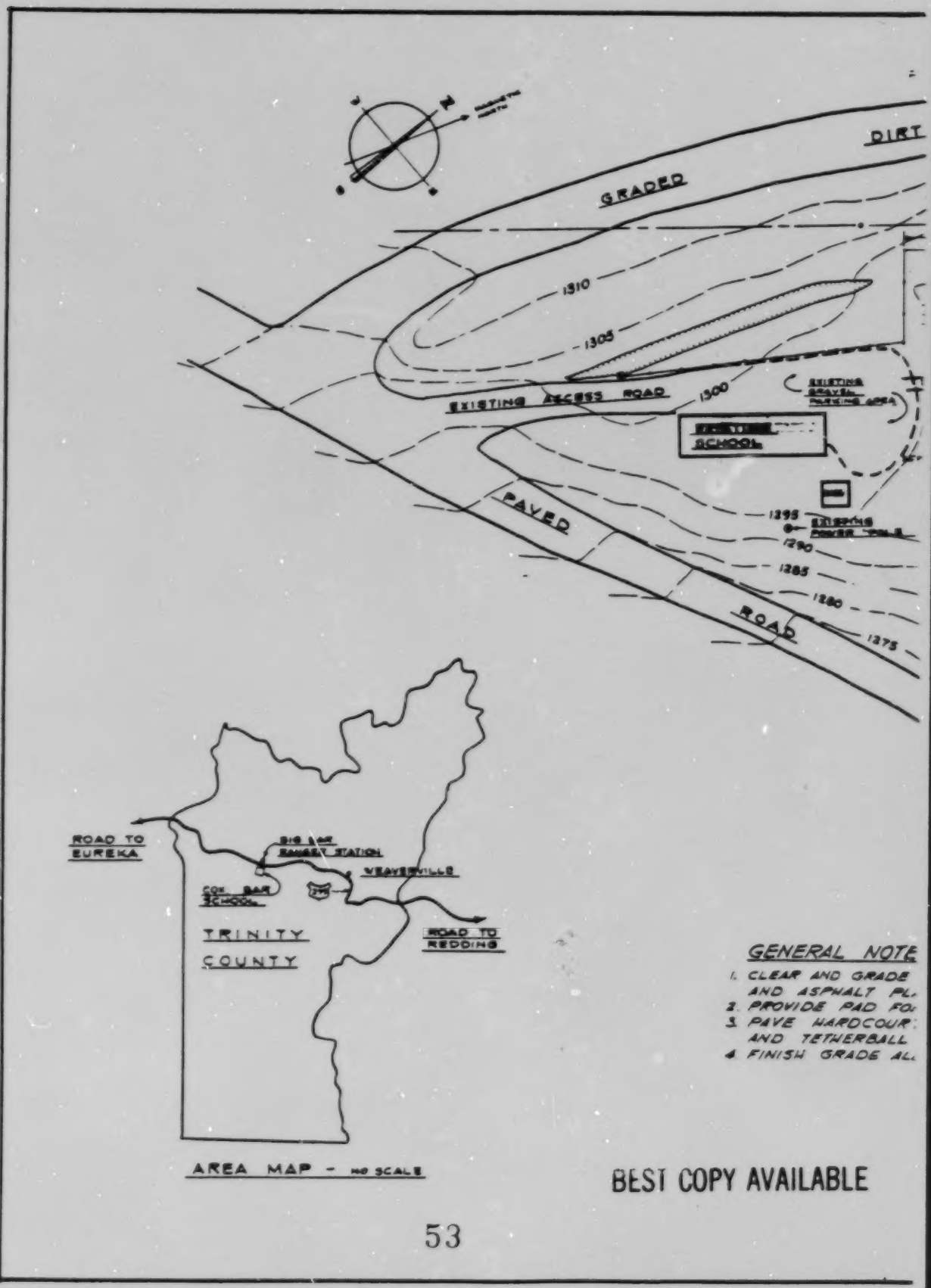
The working drawings that make up a complete set are interrelated, and they must be read together if they are to be used effectively. Information given on one drawing often clarifies information given on another, and a separate set of written specifications backs up the drawings. Also, most working drawings contain brief notes referring to other drawings or to information in the specifications that cannot well be shown by a symbol. In addition, many working drawings also include schedules--charts or tables containing data on doors, windows, special equipment, and the like.

SPECIFICATIONS AND THE CONTRACT

The written specifications that accompany a set of working drawings present all the information about the construction project that cannot be shown conveniently on the drawings. They give a detailed account of the quality of workmanship and materials that apply in every phase of the project, spell out the responsibilities of the contractor, the subcontractors, and the owners.

Drawings and specifications should agree in all details, but if they are found to be in conflict in any way, the specifications are to be followed.

WORKING DRAWINGS



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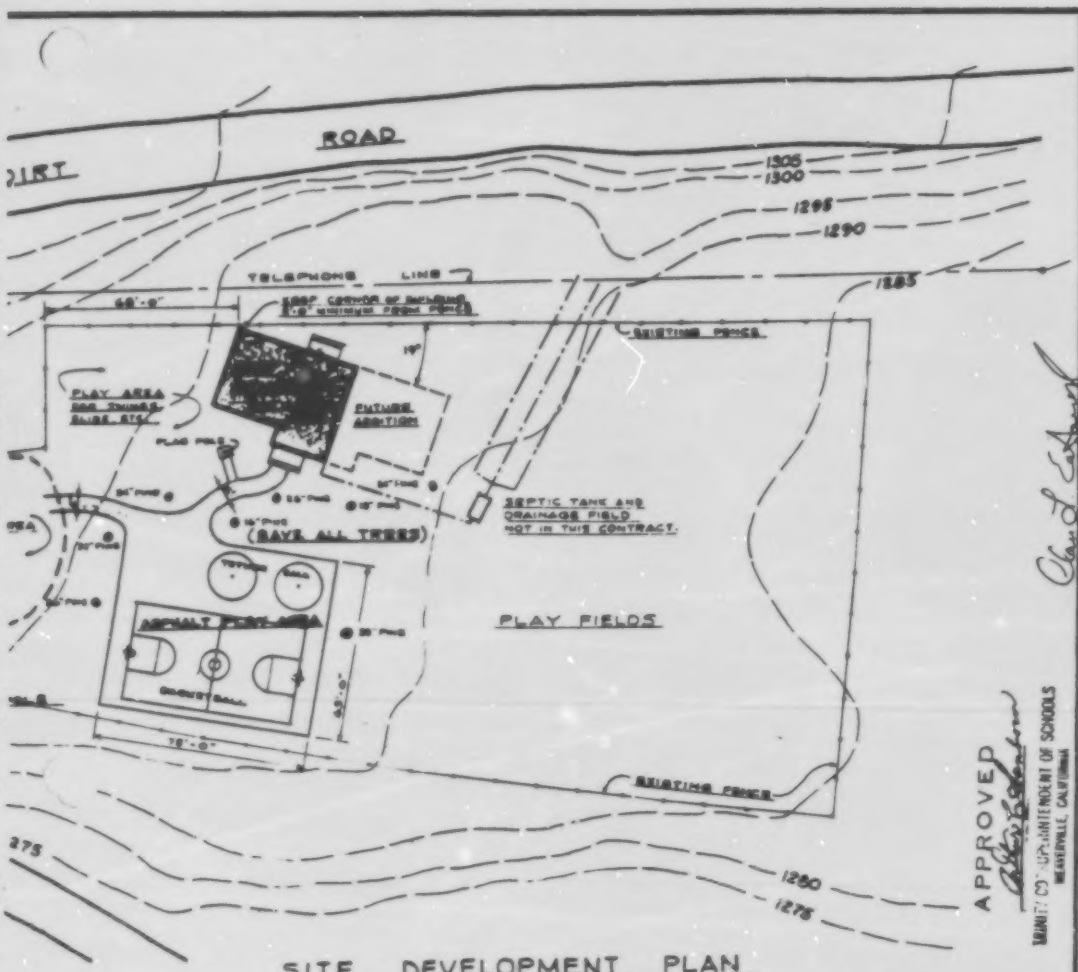

SITE DEVELOPMENT PLAN

SCALE 1" = 30'-0"

APPROVED

COUNTY SUPERINTENDENT OF SCHOOLS

APPROVALS

CALIF. STATE DEPT. OF EDUCATION
BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT

DATE: FEBRUARY, 1963

THIS PLAN IS NOT TO BE USED UNTIL LEGAL REQUIREMENTS ARE MET AND AUTHORIZATION TO PROCEED WITH CONSTRUCTION HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE

1

SITE DEVELOPMENT PLAN

COX BAR ELEMENTARY SCHOOL

NOTES: CONTRACTOR SHALL –

GRADE SITE ONLY AS REQUIRED TO CONSTRUCT NEW SCHOOL, WALKS, PLAY AREA.
FOR NEW SCHOOL AND POSSIBLE FUTURE ADDITION.
COURT PLAY AREA AND WALKS AS SHOWN. INSTALL BASKETBALL BALL STANDARDS.
SE ALL AREA WITHIN 40 FEET OF NEW SCHOOL.

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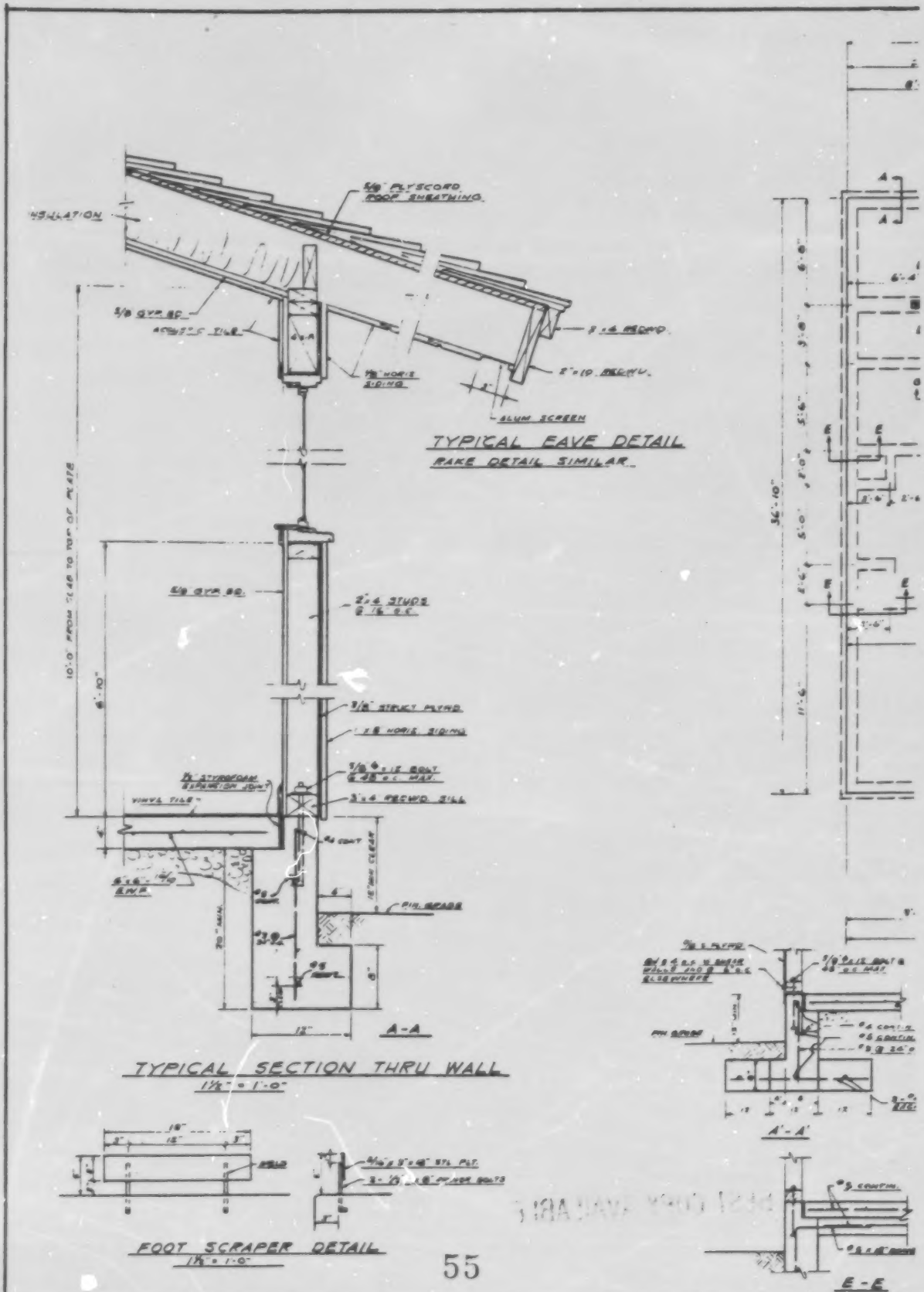

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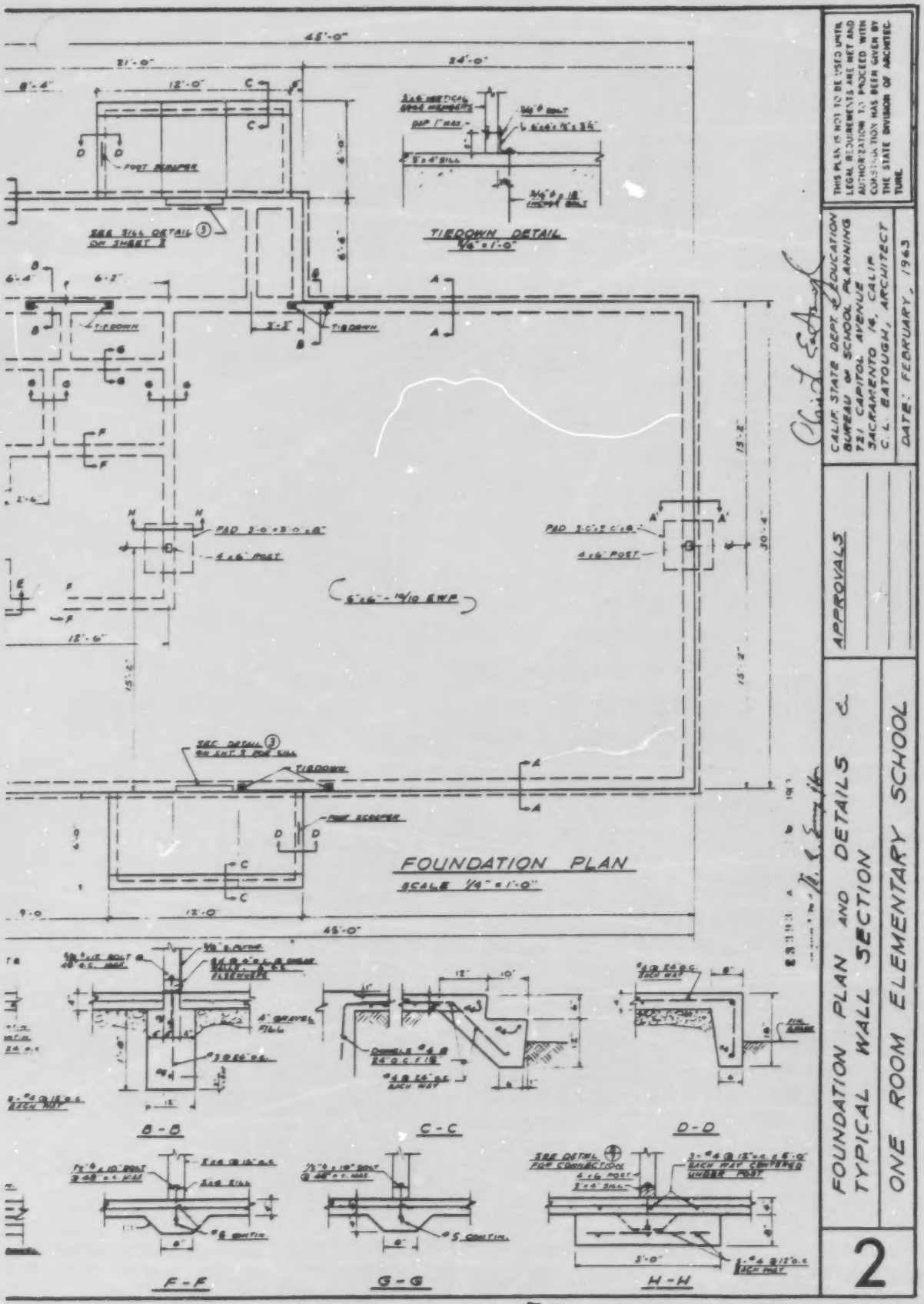

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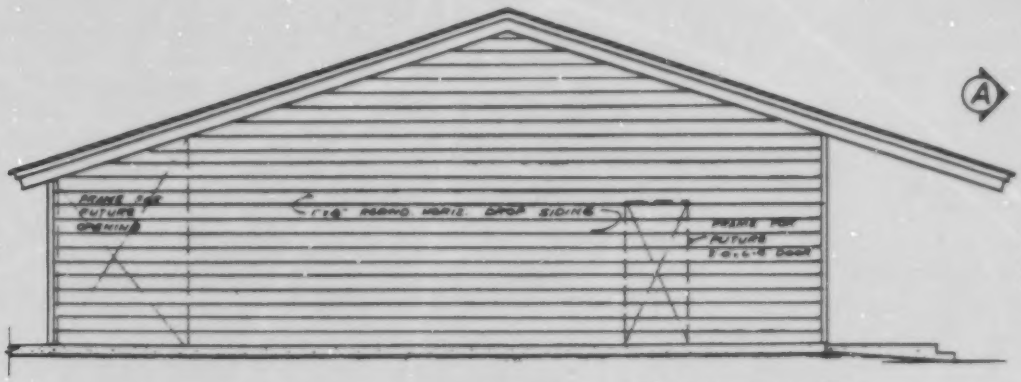
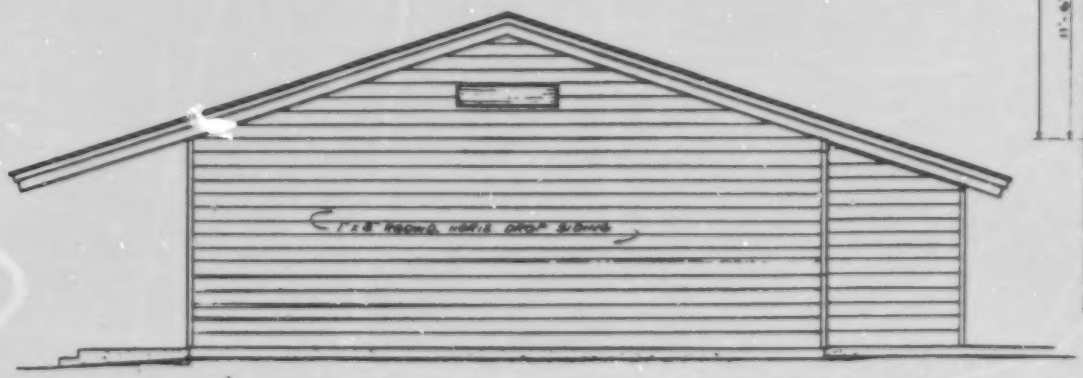
SPECIAL EQUIPMENT SCHEDULE

NOTE: THESE ITEMS ARE NOT IN THE CONSTRUCTION CONTRACT. THE SCHOOL DISTRICT MAY PURCHASE ITEMS DIRECT FROM SUPPLIER.

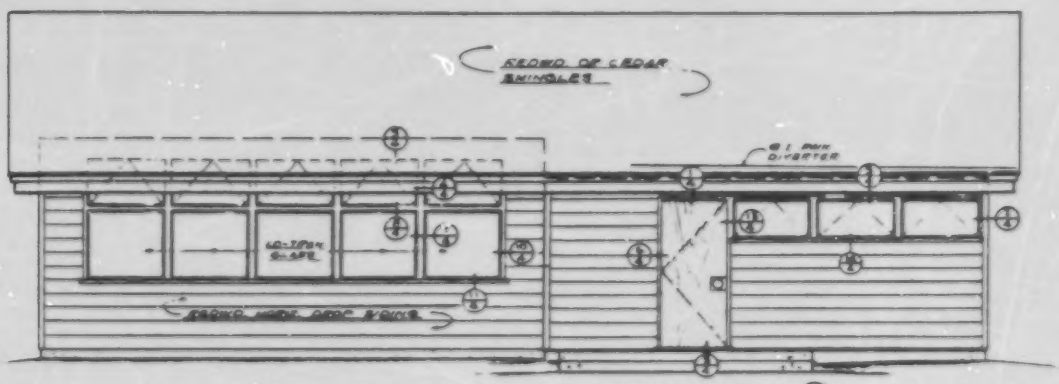
ITEM	SYMBOL	SIZE	MANUFACTURER & REMARKS
RANGE		HT. 36", WIDTH 30", DEPTH 30"	HOTPOINT MODEL HPB 300
REFRIGERATOR		HT. 73½", WIDTH 33", DEPTH 31"	PUFFER HUBBARD MODEL 31-2TC
FOLDING STAGE		OPEN 10'-0"W x 7'-9"D x 2'-8"H; CLOSED 1'-8½" DEEP	BRUNSWICK
MOVABLE STOP COUNTER		24" x 48" x 30"	EDUCATORS #403
MOVABLE DOUBLE BOOKSHELVES		24" x 48" x 30"	EDUCATORS #407
PAPER STORAGE		28" x 48" x 54"	EDUCATORS #409
PORTA-BENCH		30" x 48" x 32"	EDUCATORS #431



ELEVATION (A)



ELEVATION (C)



ELEVATION (B)

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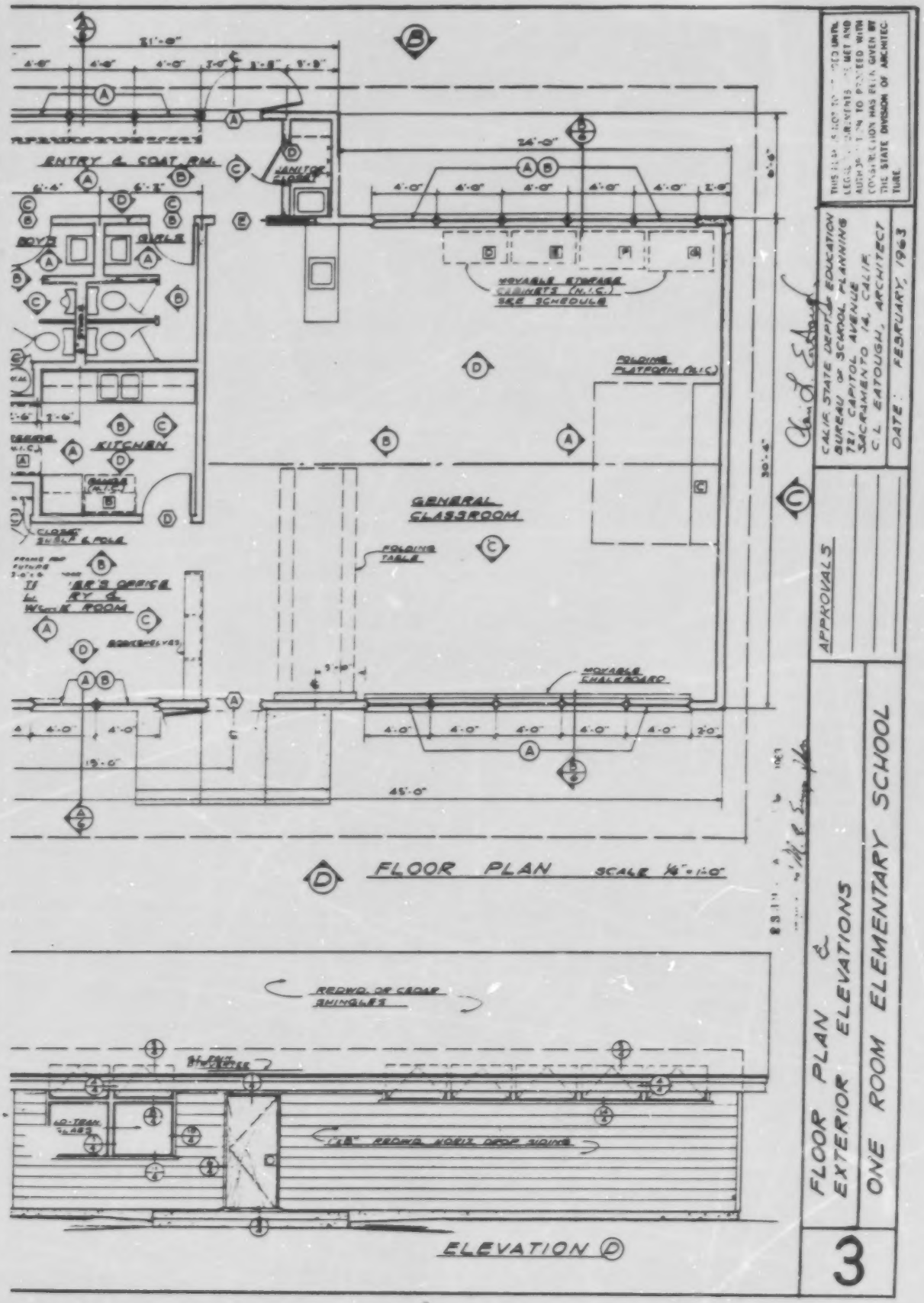

APPROVALS

CALIF. STATE DEPT. OF EDUCATION
BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT

DATE: FEBRUARY, 1963

FLOOR PLAN & EXTERIOR ELEVATIONS

ONE ROOM ELEMENTARY SCHOOL

3

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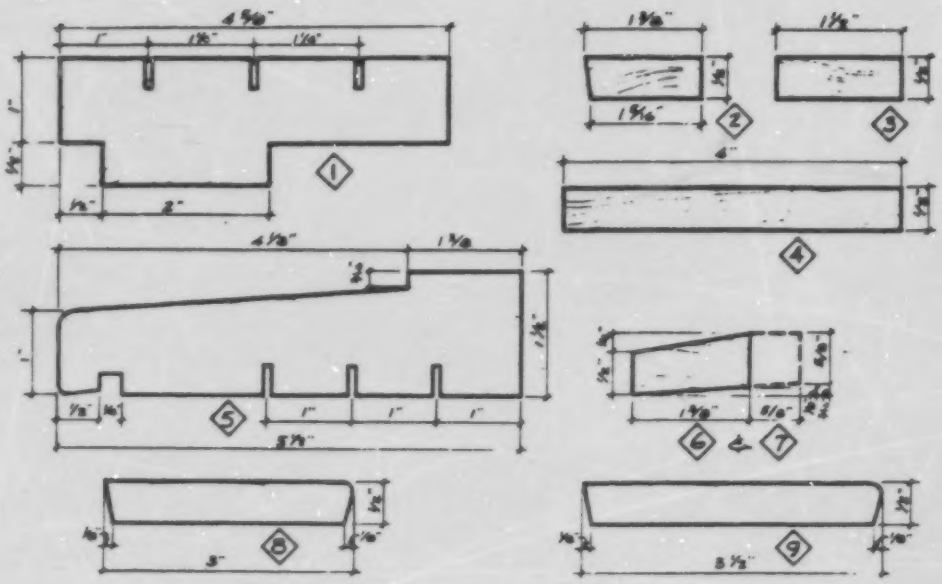


MILLWORK SECTIONS – FULL SIZE

MILLWORK SPECIFICATIONS

EXTERIOR MATERIAL – SHALL BE CLEAR, KILN-DRIED PONDEROSA PINE, TREATED WITH WATER-REPELLENT PRESERVATIVE, OR SHALL BE No 1, CLEAR, KILN-DRIED REDWOOD. ALL MILLWORK SHALL BE PRIMED ALL SIDES WITH WHITE LEAD PRIMER. GALVANIZED NAILS TO BE USED ON ALL EXTERIOR WORK.
INTERIOR MATERIAL – MAY BE No 1 CLEAR, KILN-DRIED DOUGLAS FIR. ALL MILLWORK SHALL CONFORM TO THE STANDARDS OF THE WOODWORK INSTITUTE OF CALIFORNIA.

DOOR SCHEDULE

	DOOR				HARDWARE					
SYMBOL	SIZE	TYPE	MATERIAL	REMARKS	BUTTS	SIZE	LOCK SETS	CLOSER	KICKPLATE	THRESHOLD
A	3'-6" x 7'-0"	FLUSH SLIDING DOOR, SOLID CORE	BIRCH SURFACE	WEATHERSTRIP	1½ PR @	4½ x 4½"	No 955	'400' SIZE 4	1 PER DOOR	"SB 8
B	3'-6 x 6'-8"	FLUSH SWINGER SOLID CORE	"	"	1½ PR @	4" x 4"	No 910	'300 SIZE 3	1 PER DOOR	
C	1'-10 x 6'-8"	BUILT-UP FRAME	"	"	1 PR @	3½ x 3½	No 956			
D	2'-8 x 6'-8"	SOLID CORE	"	"	1½ PR @	3½ x 3½	No 910		1 PER DOOR	
E	3'-0" x 6'-8"	SOLID CORE	"	SLIDING TYPE	NOT REQUIRED					

DOOR & HARDWARE SPECIFICATIONS

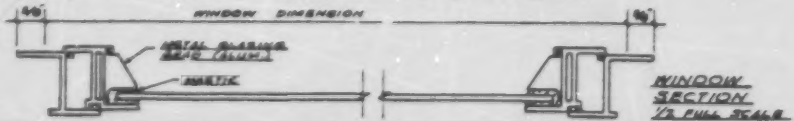
1. EXTERIOR DOORS TO BE PRE-FINISHED 'WELDWOOD' 'STAY-STRATE' DOORS, 1¾" THICK
2. LOCKSETS TO BE 'CORBIN' (SEE SCHEDULE) 'SPARTAN' DESIGN SERIES. INTERIOR DOORS ARE 1⅜".
3. DOOR CLOSERS TO BE 'CORBIN' (SEE SCHEDULE).
4. EXTERIOR BUTTS SHALL HAVE BALL BEARING UNITS WITH NON-REMOVABLE PINS, BONDERIZED AND PRIME COATED. USE 'STANLEY' OR EQUAL.
5. INTERIOR BUTTS TO BE DULL CHROME WITHOUT BALL BEARINGS.
6. TRACK FOR SLIDING DOORS SHALL BE 'SPRANT' – @ 1800 WITH NYLON ROLLERS. USE 'SPRANT' ALUMINUM FLUSH RECTANGULAR PULLS
7. THRESHOLDS FOR EXTERIOR DOORS SHALL BE 'ACCURATE' ALUM. SILLS (SEE SCHEDULE).
8. KICK PLATES TO BE 14-GA., U.S.-28, SIZE 12" HIGH BY 1" LESS THAN DOOR WIDTH. BEVEL ALL SIDES. INSTALL ON PUSH SIDE OF DOORS.
9. FINISH – ALL HARDWARE SHALL BE U.S. STANDARD 26 D UNLESS OTHERWISE INDICATED.
10. CONTRACTOR SHALL FURNISH AND INSTALL HARDWARE AS REQUIRED.

WINDOW SCHEDULE

	WINDOW					HARDWARE	
SYMBOL	SIZE	TYPE	GLAZING	MANUFACTURER	REMARKS	CATCH	SCREENS
A	3'-6"W x 3'-0"H	ALUMINUM	CLEAR	'SOULE' SERIES 900	PROJECT IN, TOP HINGED	No 9P-13	
B		FIXED	LOW TRAN		SET IN WOOD STOPS		
C		FIXED	NONE		SCREEN IN WOOD FRAME		ALUM. SCREEN

WINDOW & GLAZING SPECIFICATIONS

1. WINDOWS SHALL BE 'SOULE' SERIES 900 ALUMINUM WINDOWS OR APPROVED EQUALS. CONTRACTOR SHALL ORDER WINDOWS TO DIMENSIONS SHOWN ON THE SCHEDULE AND SHALL NOTE THAT WINDOWS ARE VENTED TO PROJECT INWARD AND HINGED AT THE TOP.
2. ALL GLAZING OF ALUM. SASH SHALL USE SNAP-IN METAL BEADS. ALL GLASS SHALL SIT IN A MASTIC BED. MAKE WATER-TIGHT. (SEE ½ FULL SIZE DETAIL, THIS SHEET).
3. LIGHT REDUCING GLASS (ALL FIXED SASH) SHALL BE FIRST QUALITY AS MANUFACTURED BY PITTSBURG GLASS CO. USE GRAYLITE No 14 GLASS. ALL GLASS SHALL BE SET WITH THE WAVE RUNNING HORIZONTALLY.
4. CLEAR GLASS (ALL VENTED SASH) SHALL BE GRADE B, ⅛" CRYSTAL.



WINDOW SECTION ½ FULL SCALE

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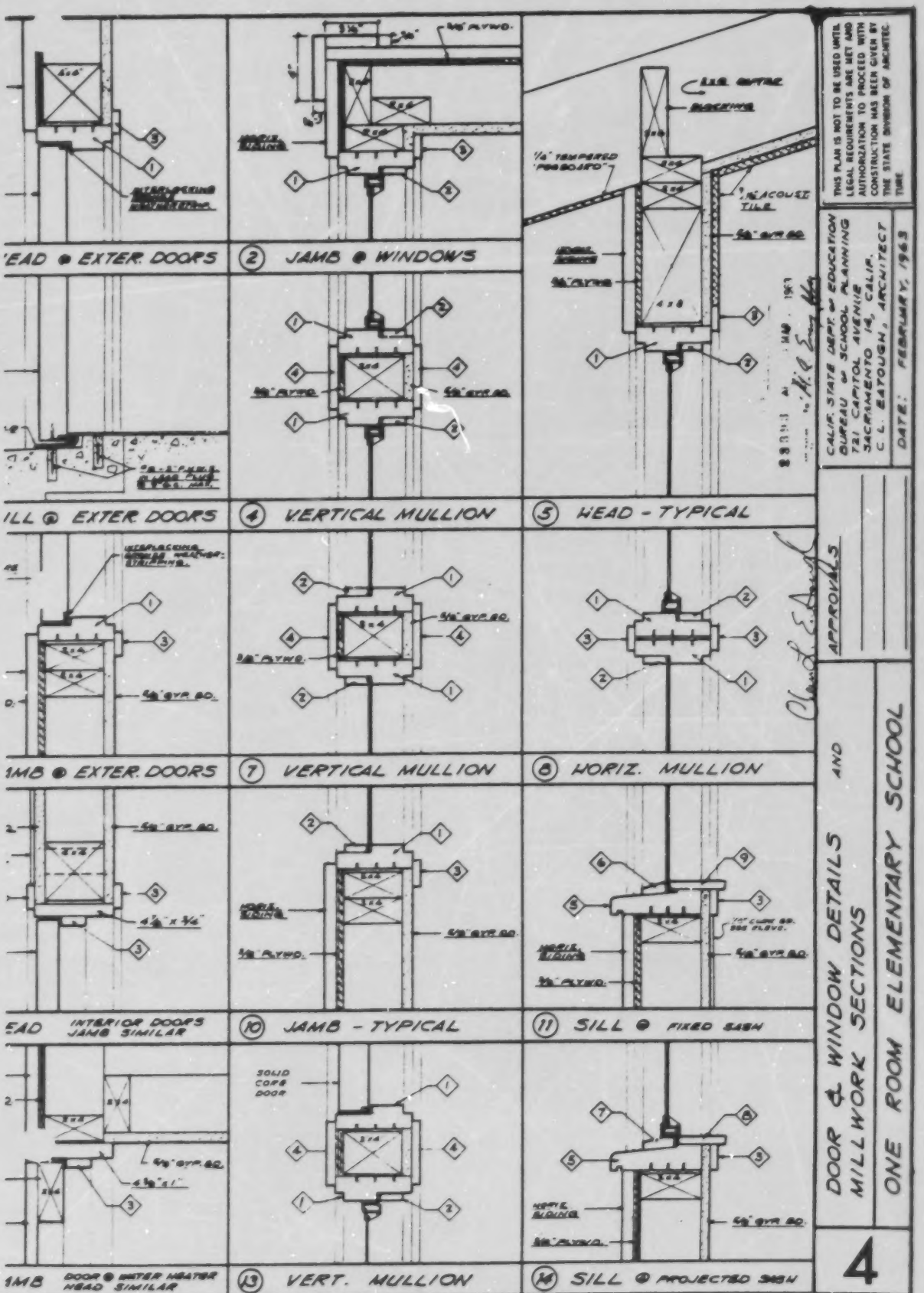
EAD @ EXTER. DOORS
(2) JAMB @ WINDOWS
ILL @ EXTER. DOORS
(4) VERTICAL MULLION
(5) HEAD - TYPICAL
IMB @ EXTER. DOORS
(7) VERTICAL MULLION
(8) HORIZ. MULLION
EAD INTERIOR DOORS JAMB SIMILAR
(10) JAMB - TYPICAL
(11) SILL @ FIXED SASH
IMB DOOR @ WATER HEATER HEAD SIMILAR
(13) VERT. MULLION
(14) SILL @ PROJECTED SASH
SOLID CORE DOOR
1/4" TEMPERED MASONITE
ACOUSTL TILE
APPROVALS
CALIF. STATE DEPT. OF EDUCATION
BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT
DATE: FEBRUARY, 1963
THIS PLAN IS NOT TO BE USED UNTIL LEGAL REQUIREMENTS ARE MET AND AUTHORIZATION TO PROCEED WITH CONSTRUCTION HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE
DOOR & WINDOW DETAILS AND MILLWORK SECTIONS
ONE ROOM ELEMENTARY SCHOOL
4

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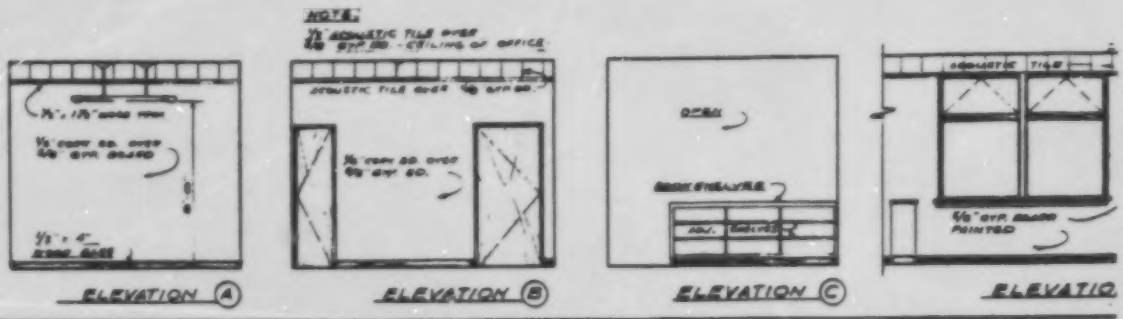
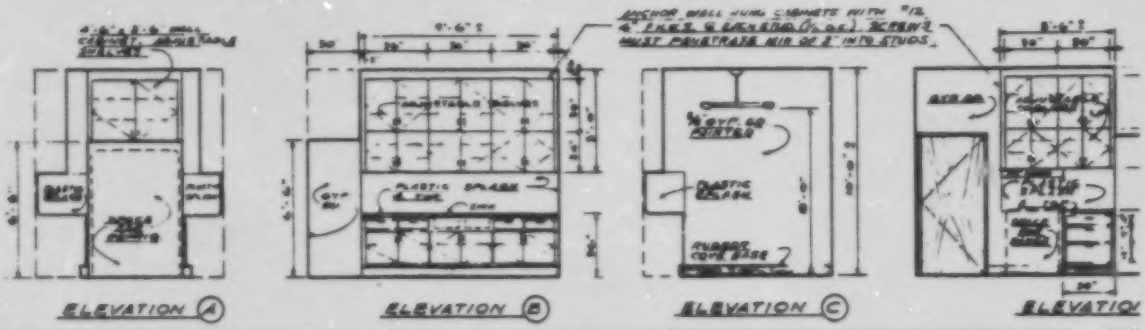
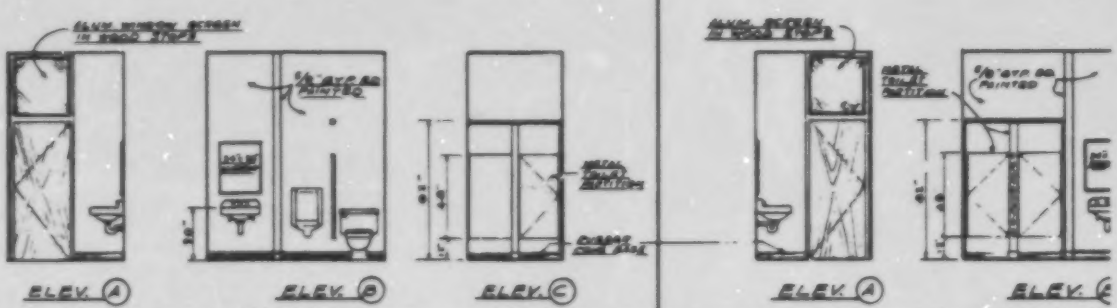


OFFICE - WORKROOM AREA

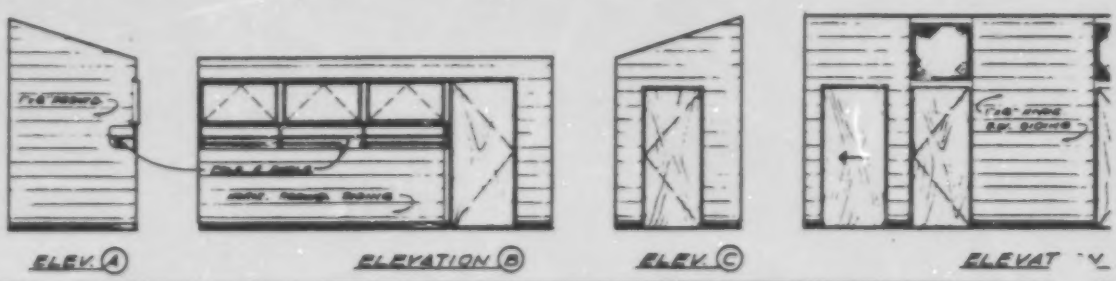


KITCHEN



BOYS' TOILET RM.

GIRLS' TOILET



ENTRY & COAT ROOM

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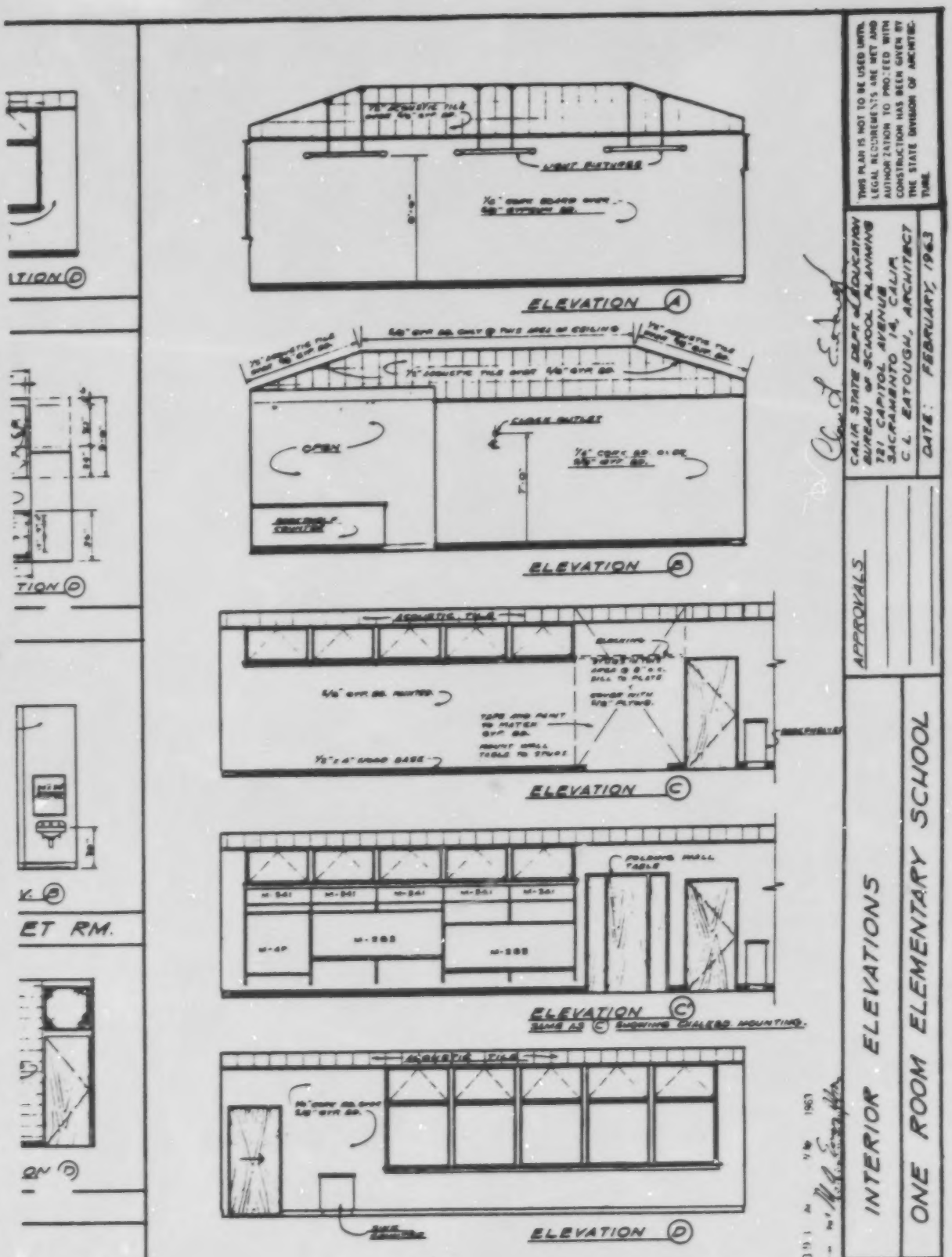

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BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT

DATE: FEBRUARY, 1963

APPROVALS

INTERIOR ELEVATIONS

ONE ROOM ELEMENTARY SCHOOL

5

GENERAL CLASSROOM

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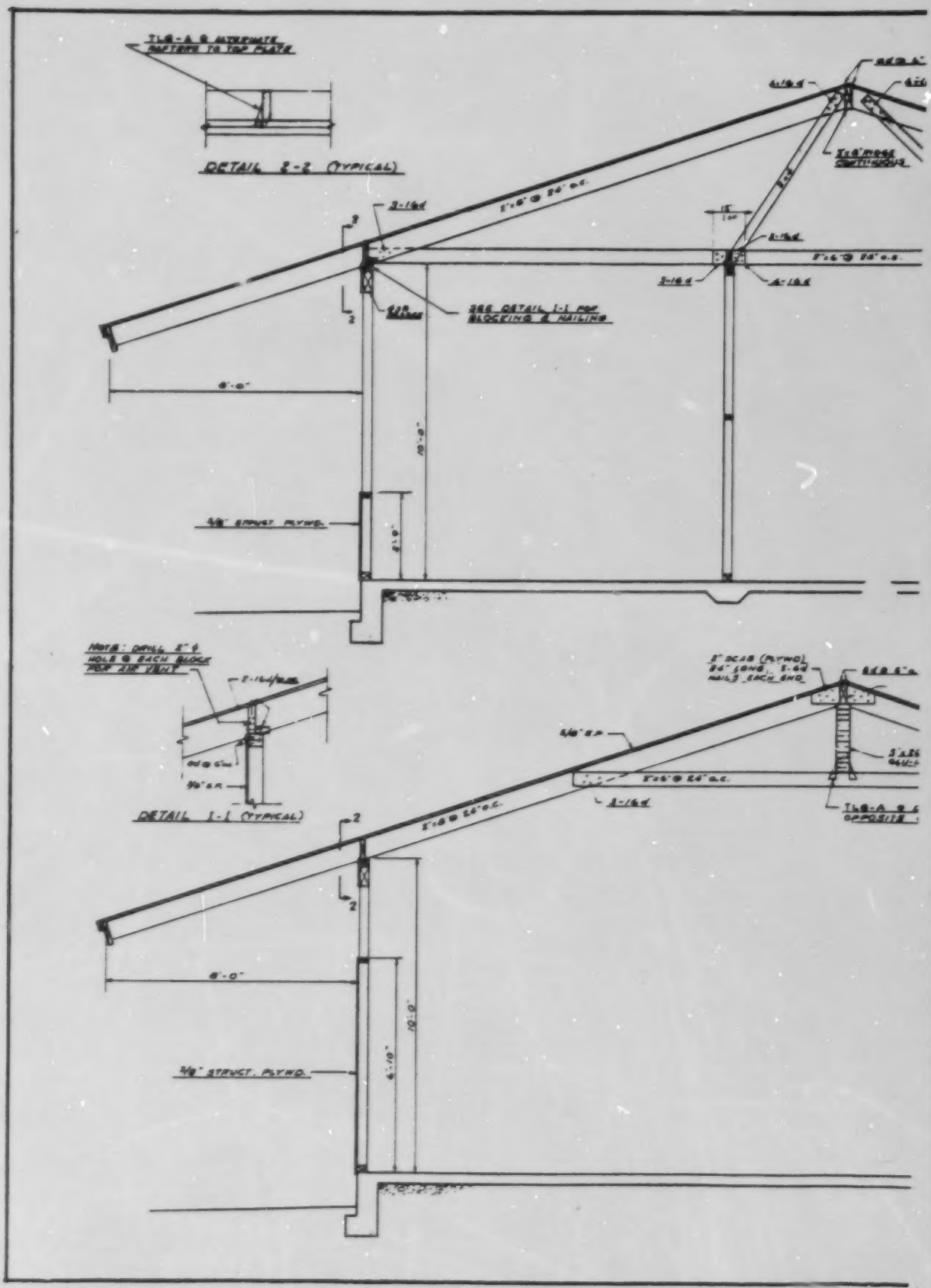

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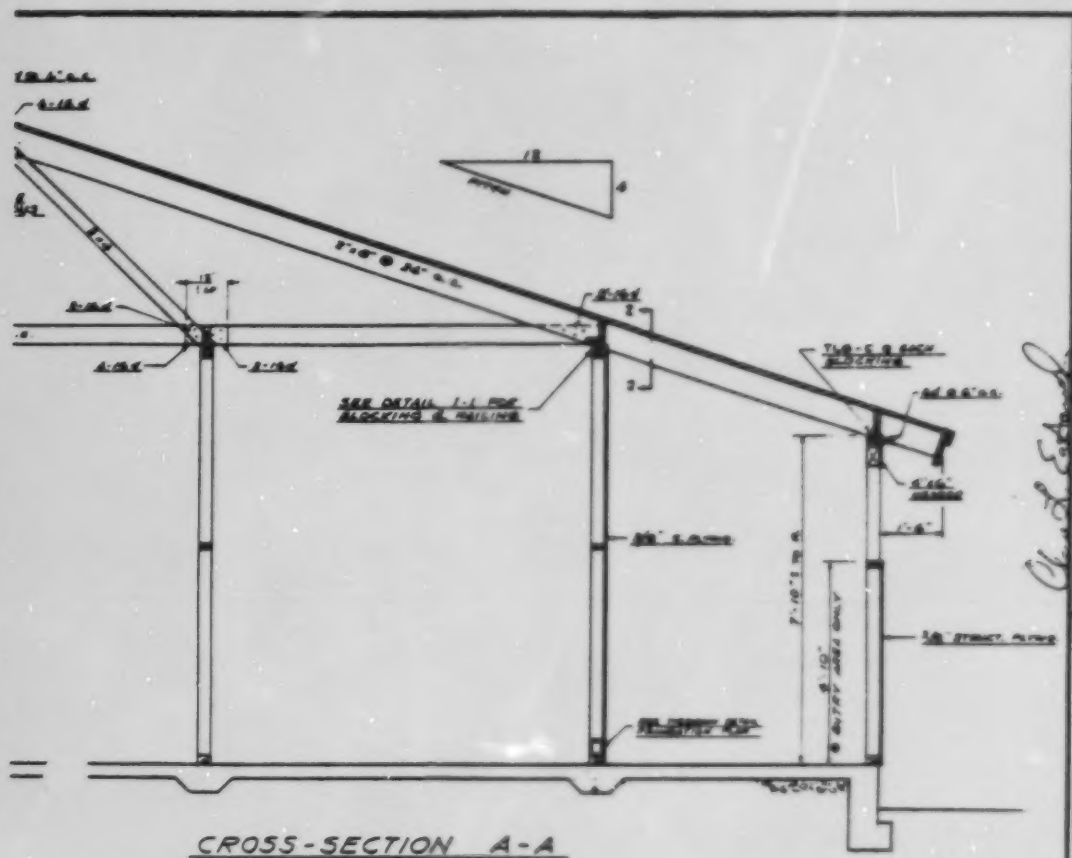
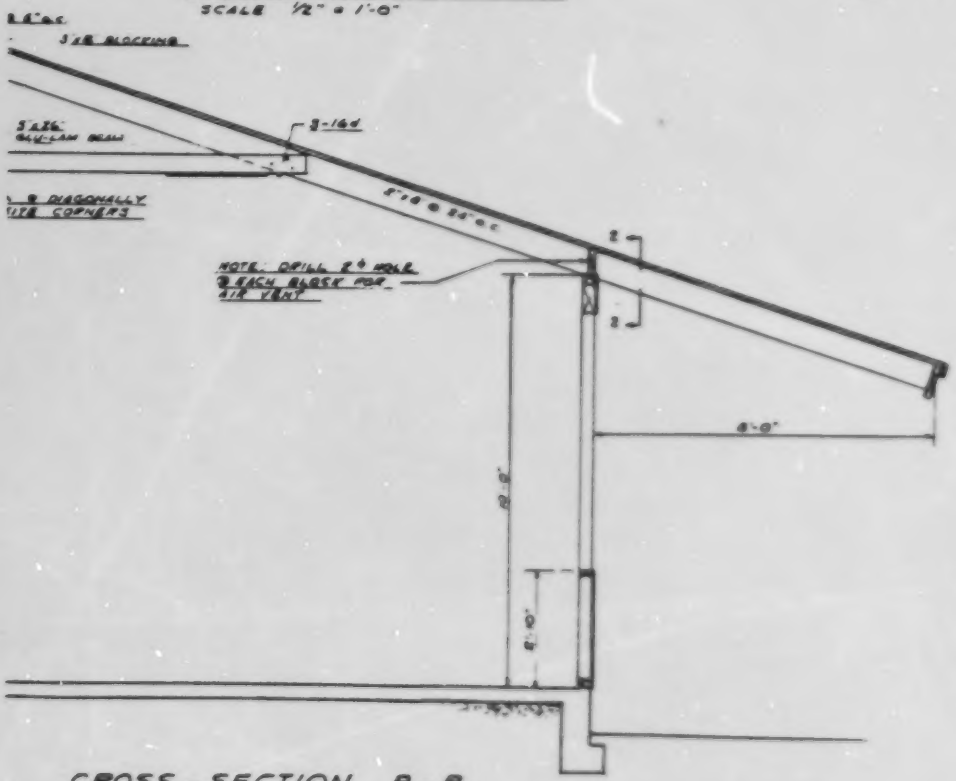


CROSS-SECTION A-A
SCALE 1/2" = 1'-0"



CROSS-SECTION B-B
SCALE 1/2" = 1'-0"

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C. L. BATOUGH, ARCHITECT

DATE: FEBRUARY, 1963

APPROVALS

STRUCTURAL FRAMING SECTIONS

ONE ROOM ELEMENTARY SCHOOL

6

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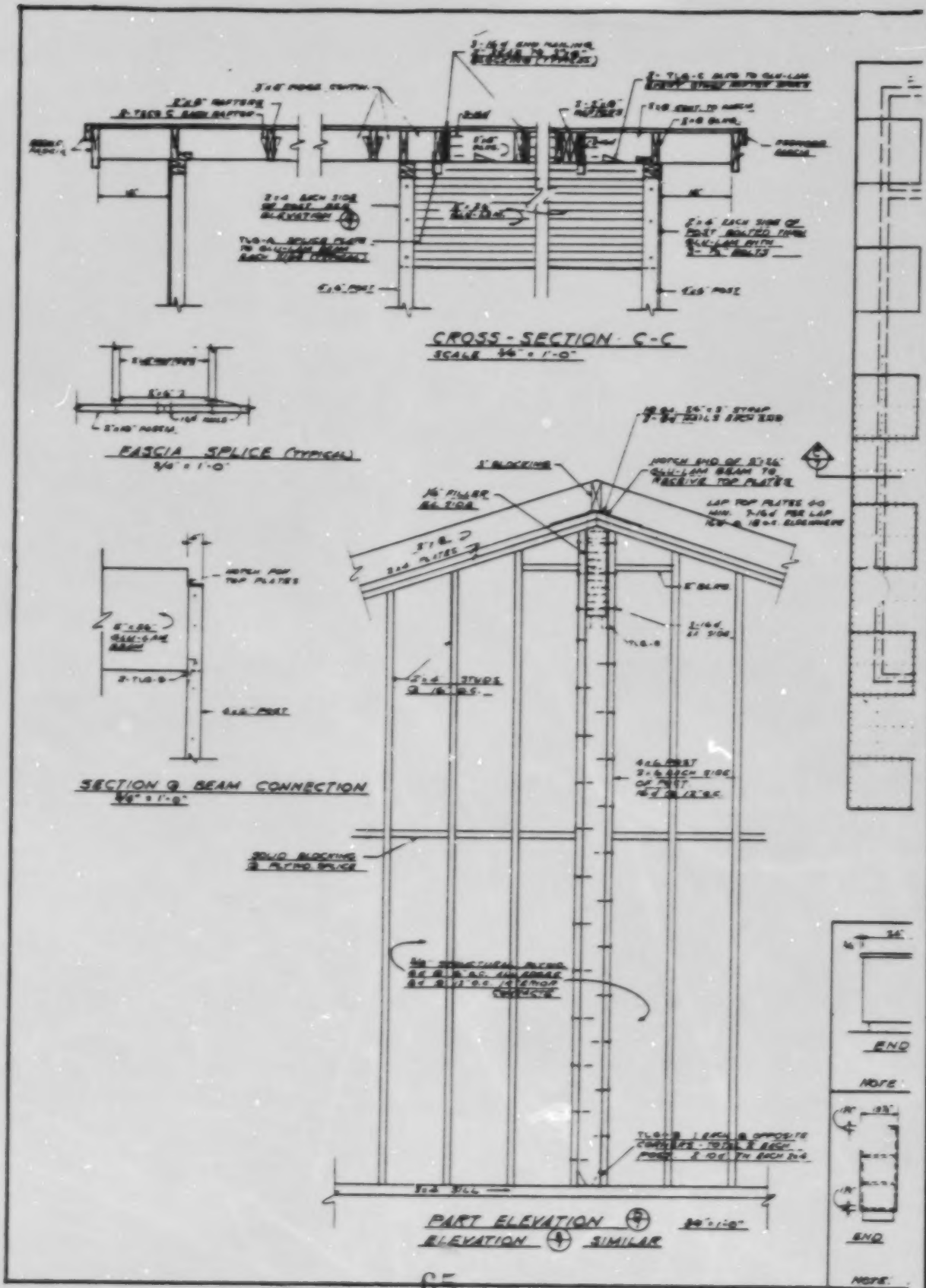

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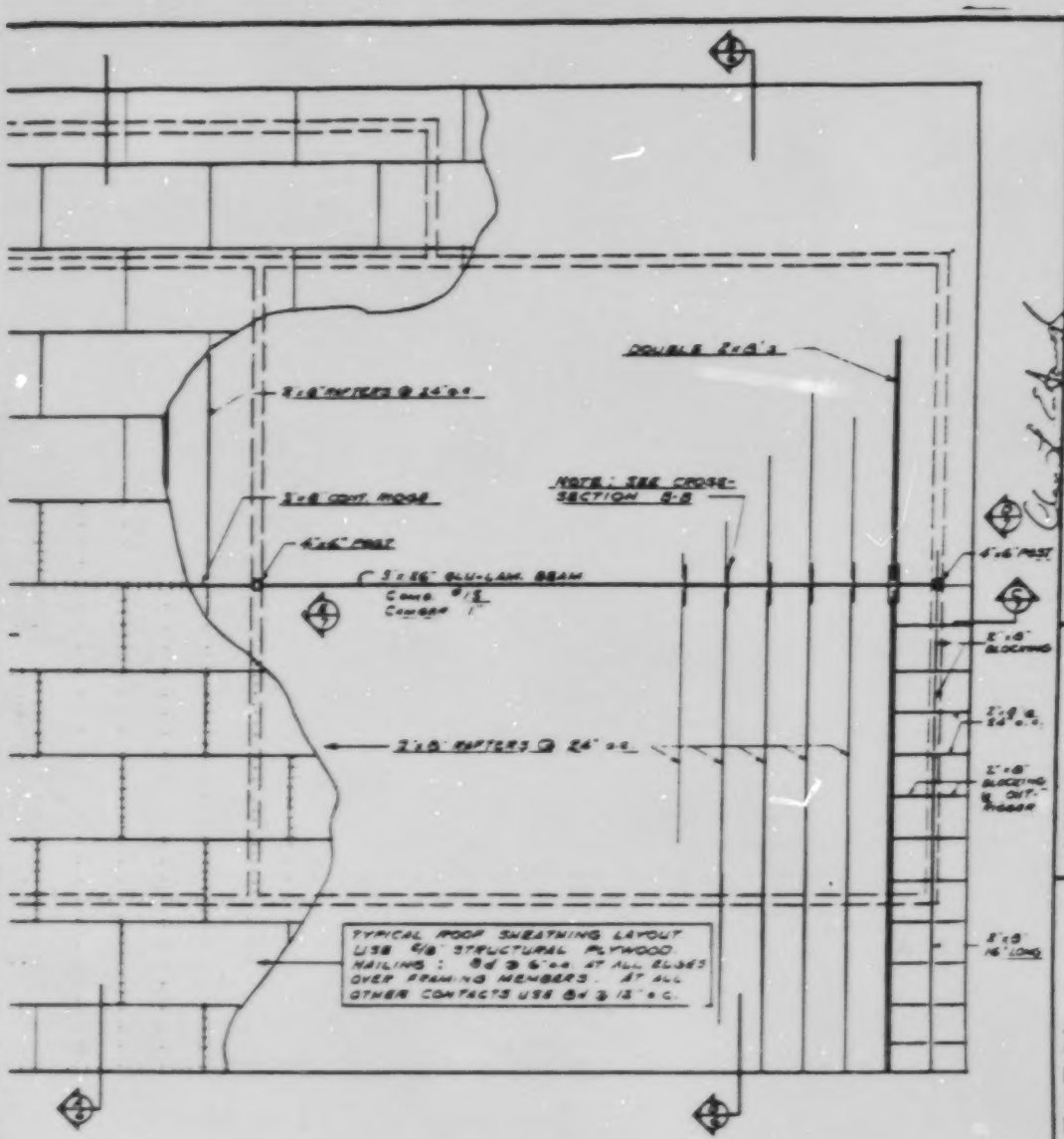
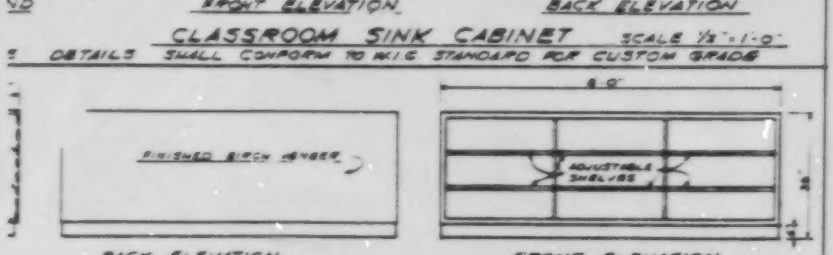

DOUBLE 2x6's
2x8 RAFTERS @ 24" o.c.
2x8 CONT. HDR.
4"x6" POST
NOTE: SEE CROSS-SECTION B-B
5 1/2" x 16" GLU-LAM. BEAM
2x8 RAFTERS @ 24" o.c.
2"x8" BLOCKING
2"x8" BLOCKING OUTRIGGER
2"x8" 16' LONG
TYPICAL ROOF SHEATHING LAYOUT
USE 5/8" STRUCTURAL PLYWOOD
NAILING: 8d @ 6" o.c. AT ALL EDGES OVER FRAMING MEMBERS. AT ALL OTHER CONTACTS USE 8d @ 12" o.c.

ROOF FRAMING PLAN SCALE 1/8" = 1'-0"

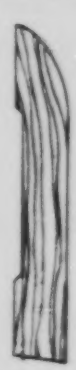
CLASSROOM SINK CABINET SCALE 1/2" = 1'-0"

DETAILS SHALL CONFORM TO W.I.C. STANDARDS FOR CUSTOM GRADE



BOOKSHELVES SCALE 1/2" = 1'-0"

DETAILS SHALL CONFORM TO W.I.C. STANDARDS FOR CUSTOM GRADE



BASE MOLDING FULL SIZE

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SACRAMENTO 14, CALIF.
C.L. EATOUGH, ARCHITECT

DATE FEBRUARY 1963

APPROVALS

ROOF FRAMING, STRUCTURAL DETAILS AND MILLWORK DETAILS

ONE ROOM ELEMENTARY SCHOOL

7

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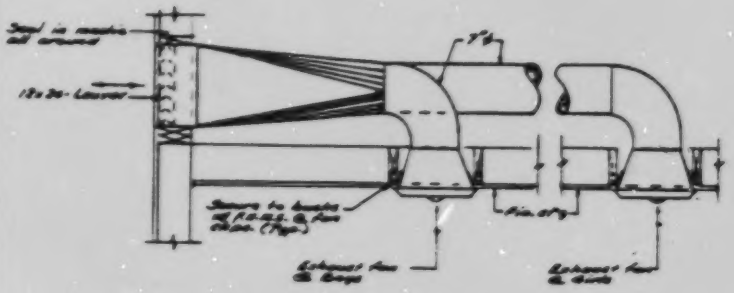
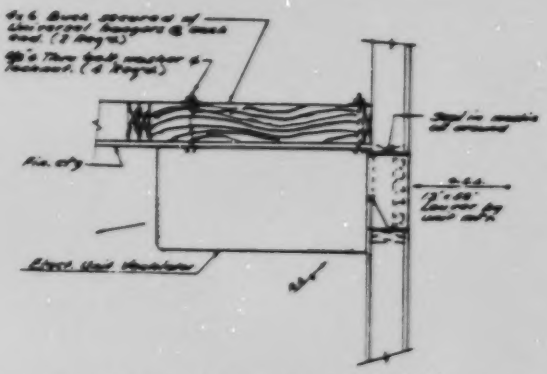
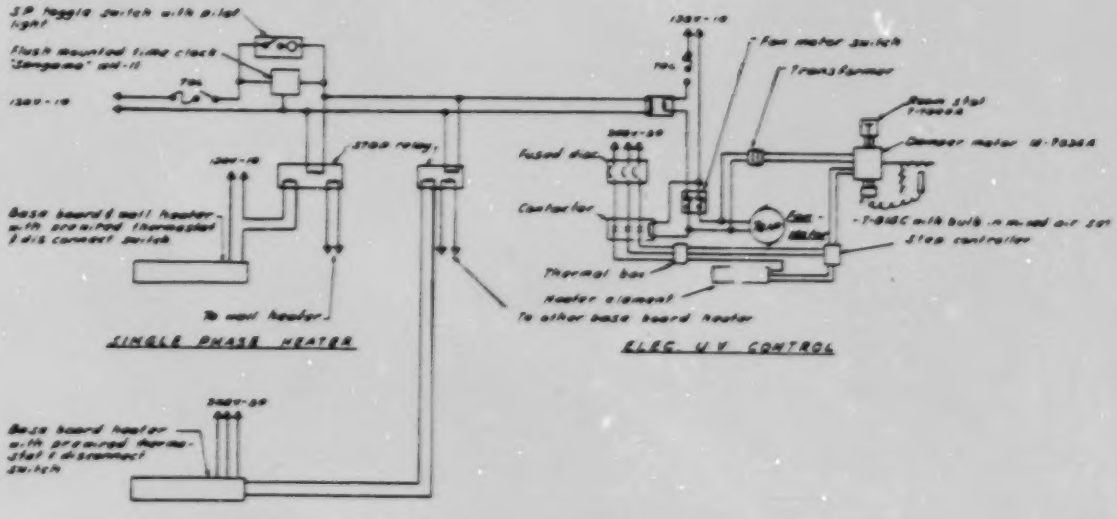


TOILET EXHAUST DETAIL (A)



ELECTRIC UNIT VENTILATOR MOUNTING DETAIL (B)



CONTROL DIAGRAM (C)

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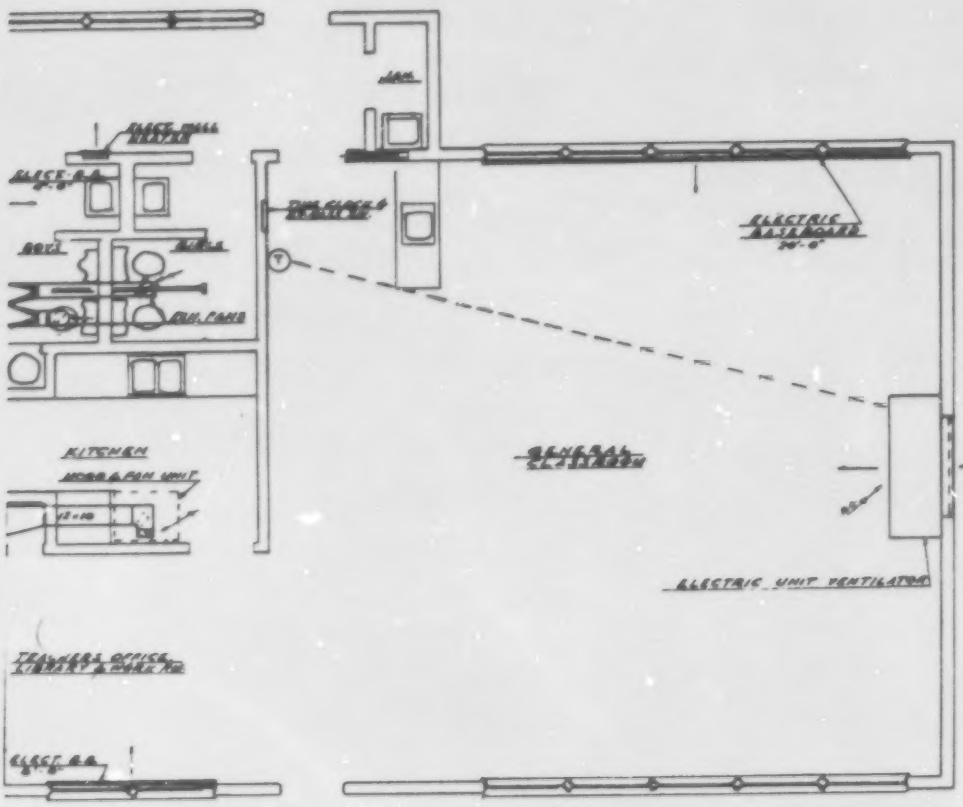

FLOOR PLAN SCALE ¼"=1'-0"

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DATE: FEBRUARY, 1943

APPROVALS

8

HEATING & VENTILATING

ONE ROOM ELEMENTARY SCHOOL

LESTER A. O'HARA, [illegible]
Mechanical Engineer
Sacramento, California

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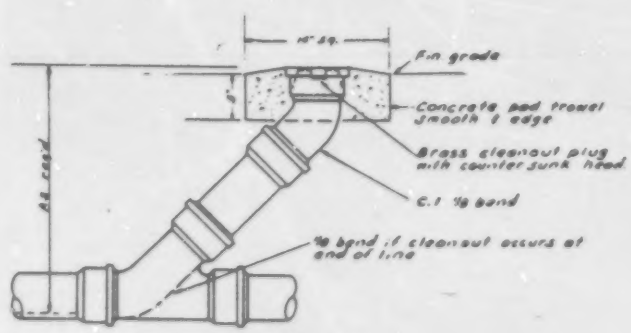
FIXTURE SCHEDULE

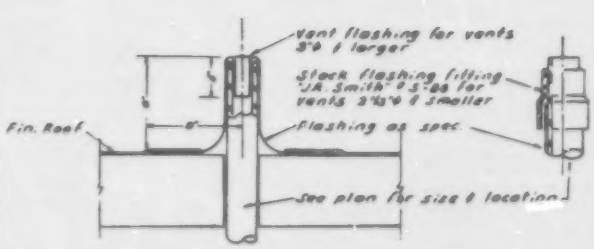
FIXTURE	SYMBOL	WASTE BRANCH	WASTE OUTLET	VENT	COLD WATER BRANCH	COLD WATER OUTLET	HOT WATER BRANCH	HOT WATER OUTLET
water closet	W.C	4"	4"	2"	1½"	1"		
Lavatory	L	2"	1½"	1½"	¾"	½"	¾"	½"
Urinal	U.R	2"	2"	1½"	1"	¾"		
Service sink	S.S	3"	3"	3"	¾"	¾"	¾"	¾"
Floor drain	F.D	2"	2"	3"				
Hose bibb	H.B				¾"	¾"		
Sink	S	2"	1½"	1½"	¾"	½"	¾"	½"

PLUMBING LEGEND

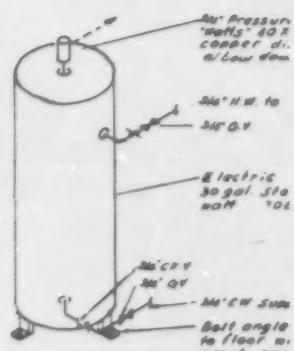
———	Soil, waste above grade
—— —— ——	Soil, waste below grade
- - - - - - - - - -	Sanitary vent
——— · ———	Cold water
——— ·· ———	Hot water
V - VR - VTR	Vent, vent riser, vent thru roof
HWR (D)	Hot water riser (drop)
CWR (D)	Cold water riser (drop)
C.O.T.F	Cleanout thru floor
C.O.T.G.	Cleanout to grade
U.F.	Under floor
O.H.	Overhead
C.I.	Cast iron
W.D.	Waste drain


Fin grade
Concrete, pad trowel smooth & edge
Brass cleanout plug with counter sunk head
C.I. ⅛ bend
⅛ bend if cleanout occurs at end of line
C.O.T.G.
Fin. floor
Cut off ferrule cleanout "Eurn: 0134
For balance of piping see C.O.T.G.
C.O.T.F.

CLEANOUT DETAILS (A)
SCALE 1½" = 1'-0"


Vent flashing for vents 3" & larger
Stack flashing fitting "J.A. Smith" 0.5.08 for vents 2½" & 3" & smaller
Fin. Roof
Flashing as spec.
See plan for size & location

VENT PIPE FLASHING (B)
SCALE 1½" = 1'-0"



ELECTRIC WATERHEA
SCALE 1½" = 1'-0"

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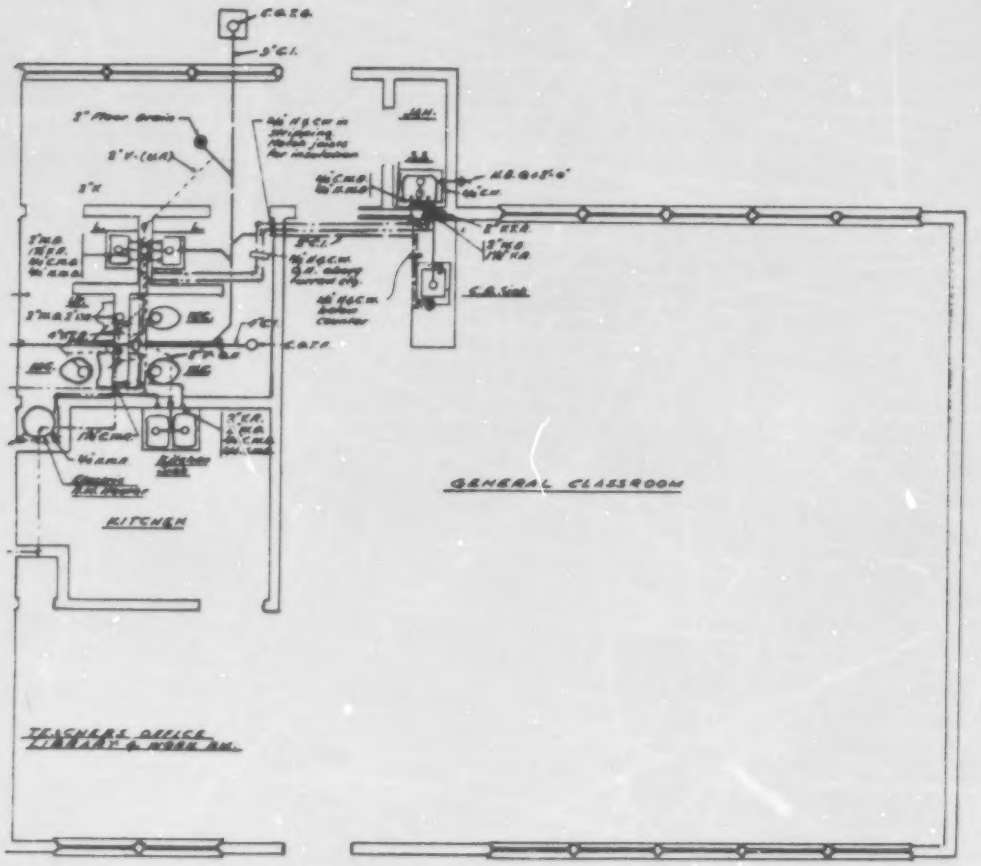

FLOOR PLAN SCALE ¼"=1'-0"

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BUREAU OF SCHOOL PLANNING
721 - CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT

DATE: FEBRUARY, 1963

PLUMBING

ONE ROOM ELEMENTARY SCHOOL

9

pressure & temp. relief valve
¾" SOIL run to hard temp
er discharge to outside
w down @ 6'0" above grade

w to sink

tric. waterheater "massive" S-30
gl storage 13gph recovery 3000
99.10

w supply

angle clips to legs and fasten
oor with ½"ø bolts @ 2 unit
h anchors

WATER HEATER DETAIL ©

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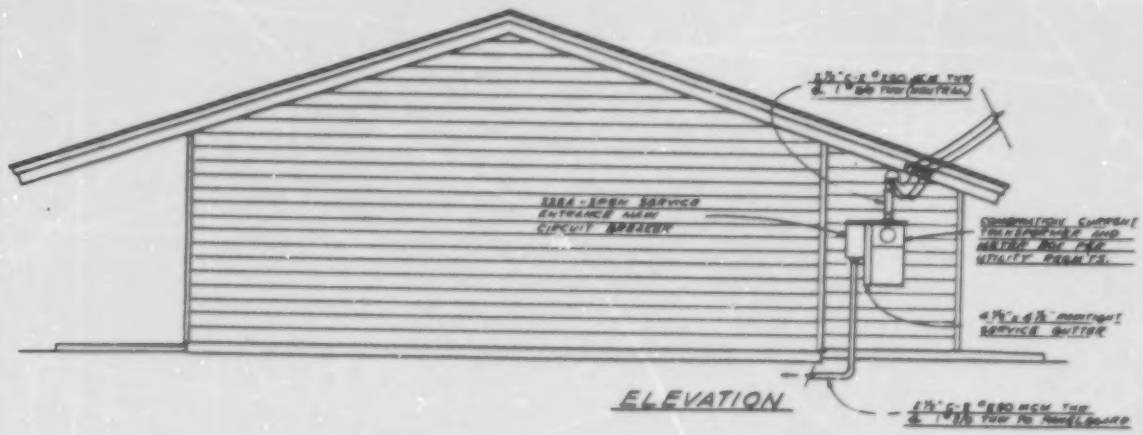

FIXTURE SCHEDULE

FIXTURE SYMBOL	MANUFACTURER	CATALOG NUMBER	LAMPS	MOUNTING	REMARKS
(A)	SUNBEAM	P132/48C-96RS	6-F96T12/HO/WW	SUSP TO 8'-0"	
(B)	SUNBEAM	P132/48A-96RS	2-F96T12/HO/WW	SUSP TO 8'-0"	
(C)	SUNBEAM	P1801/48RS	4-F40/T-12/WW	CEILING	
(D)	SUNBEAM	P1702/48RS	2-F40/T-12/WW	CEILING	
(E)	PRESCOLITE	1010 - 6&14	1-100A	RECESSED	W/TRIMLITE PR. SCREWS & PLASTER FRAME
(F)	HOLOPHANE	415	1-100A	WALL	
(G)	CROUSE HINDS	ARB-31	1-60A	CEILING	WITH OPAL GLOBE

SYMBOL SCHEDULE

- FLUORESCENT LIGHTING FIXTURE
- INCANDESCENT FIXTURE - CEILING MOUNTED
- INCANDESCENT FIXTURE - RECESSED
- INCANDESCENT FIXTURE - WALL MOUNTED
- SINGLE POLE TOGGLE SWITCH @ +48" UNLESS NOTED OTHERWISE
- THERMAL OVER SWITCH, SIZE AS REQUIRED, @ 6'-0" UNLESS NOTED, KEY OPERATED.
- SWITCH SUBSCRIPTS : a - LTS SWITCHED, K - KEY OPERATED
- SPEED SWITCH. SUPPLIED BY MECHANICAL CONTRACTOR, CONNECTED BY ELECT. CONTR.
- DUPLEX RECEPTACLE @ +18" UNLESS NOTED. (A & H #5252)
- CLOCK OUTLET (A & H #5708)
- JUNCTION BOX, SIZE AS REQUIRED
- BASE BOARD HEATER, NOT IN ELECTRICAL CONTRACT, CONNECTED BY ELECT. CONTRACTOR
- WALL HEATER
- UNIT VENTILATOR TIME CLOCK & BY-PASS SUPPLIED BY MECH CONTR. CONNECTED BY ELECT. CONTR.
- MOTOR. N.I.E.C., CONNECTED BY ELECT. CONTR.
- CONTROL EQUIPMENT. N.I.E.C., CONNECTED BY ELECT. CONTR.
- PANEL BOARD
- CONDUIT RUN CONCEALED IN FLOOR
- CONDUIT RUN CONCEALED IN CEILING OR WALL
- RANGE OUTLET 50 AMP 4 WIRE RECEPTACLE & PLATE (A & H #5151) AND CORD SET (A & H # 5714A)
- THERMOSTAT N.I.E.C., CONNECTED BY ELECT. CONTR.
- HOMERUN TO PANEL BOARD. ANY CIRCUIT WITHOUT FURTHER DESIGNATION INDICATES A 2-#12 WIRE CIRCUIT. # #12 WIRE AS SHOWN AS ——o——; 4-#12 WIRE AS ——oo——, ETC. OTHER WIRE SIZES SHOWN AS FOLLOWS : —#10— 3-#10; —#8— 4-#8; —#6— 3-#6, ETC.

PANEL BOARD

WESTINGHOUSE TYPE NQC-NDP-3L 36" FLUSH WITH

14-20A-1P CBR	CIRCUITS	1 THRU 13
4-20A-2P CBR	CIRCUITS	14, 15, 17
1-30A-2P CBR	CIRCUIT	16
1-50A-2P CBR "E" FRAME	CIRCUIT	18
1-100A-3P CBR "E" FRAME	CIRCUIT	19

FULL HINGED LOCKABLE DOOR 36" WIDE MINIMUM

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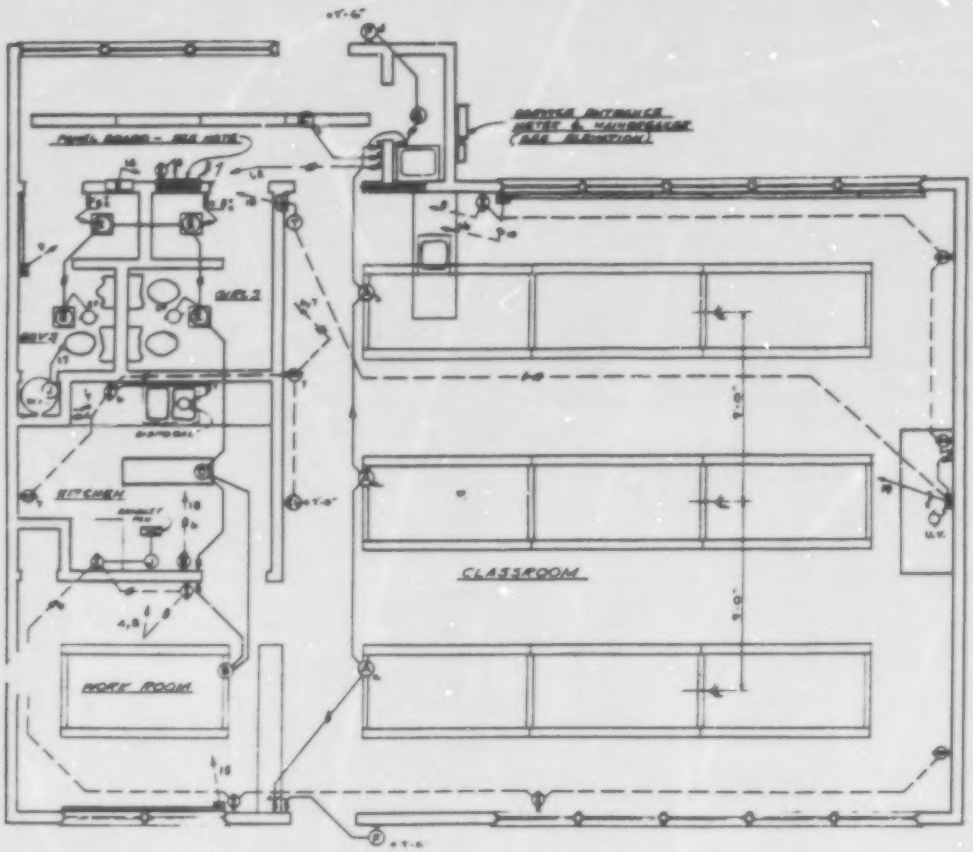

FLOOR PLAN

THIS PLAN IS NOT TO BE USED UNTIL LEGAL REQUIREMENTS ARE MET AND AUTHORIZATION TO PROCEED WITH CONSTRUCTION HAS BEEN GIVEN BY THE STATE DIVISION OF ARCHITECTURE

CALIF. STATE DEPT OF EDUCATION
BUREAU OF SCHOOL PLANNING
721 CAPITOL AVENUE
SACRAMENTO 14, CALIF.
C. L. EATOUGH, ARCHITECT

DATE: FEBRUARY, 1963

APPROVALS

ELECTRICAL

ONE ROOM ELEMENTARY SCHOOL.

10

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Self Assessment

After you have read the Information material, answer the questions below, referring to the working drawings at the back of the module as directed. Write each answer in the space provided at the right of the question.

LOOK AT THE AREA MAP ON SHEET 1, AND ANSWER QUESTIONS 1-2.

1. In what county is the school to be located? _____

2. What scale is used for the area map? _____

LOOK AT THE SITE DEVELOPMENT PLAN ON SHEET 1, AND ANSWER QUESTIONS 3-4.

3. What are the dimensions of the asphalt play area? _____

4. The main entrance to the school faces in what direction? _____

LOOK AT THE FOUNDATION PLAN ON SHEET 2, AND ANSWER QUESTIONS 5-9.

5. Anchor bolts of what size are to be used to fasten the sill to the pad? _____

6. What is the scale of the foundation plan? _____

7. Bolts of what size are to be used to anchor the foot scrapers? _____

8. How thick is the floor slab? _____

9. What is the height from the slab to the top of the plate? _____

LOOK AT THE FLOOR PLAN AND ELEVATIONS ON SHEET 3, AND ANSWER QUESTIONS 10-12.

10. What material is to be used for the exterior siding? _____

11. How many exterior doors are there? _____

12. Approximately how many square feet of floor area does the teacher's office have? _____

LOOK AT THE DOOR AND WINDOW DETAILS ON SHEET 4, AND ANSWER QUESTIONS 13-14. REFER AGAIN TO PREVIOUS SHEETS AS NECESSARY.

13. What material is specified for the outside doors? _____

14. What type of door is specified for the kitchen? _____

LOOK AT THE INTERIOR ELEVATIONS ON SHEET 5, AND ANSWER QUESTION 15.

15. What material is to be used to finish the walls in the coatroom? _____

LOOK AT THE STRUCTURAL FRAMING AND ROOF FRAMING SECTIONS (SHEETS 6 AND 7), AND ANSWER QUESTIONS 16-17.

16. Nails of what size are to be used on the roof sheathing? _____

17. How deep is the classroom sink cabinet from front to back? _____

LOOK AT THE HEATING AND VENTILATING, PLUMBING, AND ELECTRICAL PLANS (SHEETS 8, 9 AND 10), AND ANSWER QUESTIONS 18-20.

18. In what room is a thermostat to be located? _____

19. What means of ventilation is provided in the lavatories? _____

20. In how many places are hot water taps to be located? _____

Self Assessment Answers

1. trinity
2. 1" = 30'
3. 75' x 65'
4. south
5. 3/4"
6. 1/4" = 1'
7. 1/2" x 8"
8. 4"
9. 6"
10. 1" x 8" redwood
11. two
12. 175 sq. ft.
13. weldwood
14. solid core birch surface
15. horizontal redwood siding
16. 8d
17. 24"
18. general classroom
19. 12" x 24" louvred opening
20. three

Post Assessment

Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

1. ____ Which one of the following kinds of information could a worker expect to find in a set of working drawings for a building?

   a. grades of lumber to be used
   b. quality of paint required
   c. separate sheets of details for the different crafts
   d. the time limit for completion of the project

2. ____ Which one of the following kinds of information would normally appear in the specifications for a building?

   a. locations of utilities at the site
   b. quality of plumbing fixtures required
   c. dimensions of footings
   d. grade contours

3. ____ On which one of the following kinds of working drawings could a carpenter expect to find information about roof structure?

   a. plot plan
   b. exterior elevations
   c. foundation plan
   d. floor plan

4. ____ The arrangement of rooms is shown on a:

   a. site development plan
   b. floor plan
   c. detail drawing
   d. shop drawing

5. ____ The symbol (T) on an electrical plan indicates a:

   a. timer
   b. thermostat
   c. duplex receptable
   d. junction box

6. ____ A chart appearing on a working drawing giving the names, sizes, and manufacturers of special equipment is called a:

   a. schedule
   b. specification
   c. detail
   d. cross section

7. ____ Before placing electrical outlets in a new building, the electrician will consult the:

   a. architect
   b. general contractor
   c. building superintendent
   d. electrical plan

8. ____ A characteristic of a plan view (floor plan or foundation plan) is that it:

   a. shows more detail than any other type of working drawing
   b. shows the interior construction of partitions
   c. reveals the structure as it would be viewed from above
   d. includes all necessary specifications for the project

9. ____ An exterior elevation is a view of one side or face of a building from a viewpoint:

   a. slightly above and to the right of the side shown
   b. slightly below and to the left of the side shown
   c. directly in front of the side shown
   d. that reveals the maximum number of building details

10. ____ Contour lines are normally found on the:

   a. plot plan
   b. foundation plan
   c. floor plan
   d. elevations

INDIVIDUALIZED LEARNING SYSTEMS

5.4

WORKING DRAWINGS FOR MACHINING AND WELDING

Goal:

Upon completion of this module, the student will be acquainted with the lines, fundamental dimensions and materials symbols necessary to understand simple blueprints used in the trades.

Performance Indicators:

The student will demonstrate an understanding of the subject by:

1) completing a short Self Assessment exam, which tests comprehension of the subject
2) completing a Post Assessment exam which requires the student to look at a simple working drawing and a figure and answer 12 problems.

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Study Guide

In order to successfully complete this module, do the following tasks in the order in which they are presented. Check them off as you complete them.

1. ___ Familiarize yourself with the Goal and Performance Indicators presented on the cover of this module. This will inform you of what you are expected to gain from the study of this module, as well as how you will be expected to demonstrate your competence.

2. ___ Study the Introduction and Information sections. These will provide you with the knowledge necessary to complete the Self and Post Assessment exams.

3. ___ Complete the Self Assessment exam, referring to the Information section or asking your instructor when necessary. Compare your answers with those found on the Self Assessment Answer Sheet immediately following the exam. This will demonstrate how well you can expect to do on the Post Assessment exam.

4. ___ Take the Post Assessment exam and turn your answers in to your instructor for grading. It is recommended that you score 90 percent or better before going on to another module.

Introduction

From the past modules in the subject, you have seen the importance of prints in general, and what they may contain, of views of an object and how they may be rendered on paper, and of the types of drawings and how they are dimensioned.

This module takes a closer look at the fine points of working drawings for the machining and welding trades.

Information

A working drawing must give the worker exact information as to the size and shape of an object, as well as any other information necessary to finish the product. All of these concepts are done in lines, dimensions, and notes or symbols. Module 3 of this section, "Types of Drawings and Views," introduced some of the types of lines used in print making.

The following examples refer to the machine and welding trades:

Object line, used to show visible edges or contour of an object.

Hidden line, used to show the hidden features of an object.

Center line, used to show axes of symmetrical parts, and aid in dimensioning.

Extension line, used to indicate the termination of a dimension.

Dimension line, used to indicate the extent and direction of dimensions.

Cutting plane or viewing plane line, used to indicate the location where an imaginary cut is made through an object and the viewing position of the piece removed. The arrowhead points in the direction in which the section should be viewed.

Short break line, used to indicate a short break on a partial section of an object in order to conserve space on a drawing.

Long break line, used to show long breaks.

Phantom line, used to show adjacent parts, alternate positions, and lines of motion. ——— – – ———

Section lines, used to show cut surfaces of an object. ////////////////////

Leader, used to point to a surface for the purpose of dimensioning or adding a note. ——————►

Fig. G-1 on the following page demonstrates the types of lines used in a typical working drawing.

As you'll recall, dimensions were another of the necessary components of a working drawing. Dimensions indicate the size of an object or any part of an object, and are written three ways: 1) as a fraction - 4 1/2", 1 7/16", etc., 2) as a decimal - .5", .9917", etc. 3) as an angle - 45^{o}, 36^{o}, etc. The angular measurement may be broken down further into minutes (') and seconds (") for more exact measure. A minute is 1/16 of a degree and a second is 1/60 of a minute. Therefore, an angle greater than 45 degrees but less than 46 degrees could be expressed $45^{o}30'30"$. This would represent a measurement of about 1/100 of a degree larger than 45 1/2 degrees. Fig. G-1 on the following page demonstrates dimensions used in a typical working drawing.

Dimensions usually allow for a very slight acceptable error. It is demonstrated by a plus (+) sign on top of a minus (-) sign, like this $\pm$ .001", which means the print allows for an error of dimension up to 1/1000 of an inch too large or too small, but no greater or less.

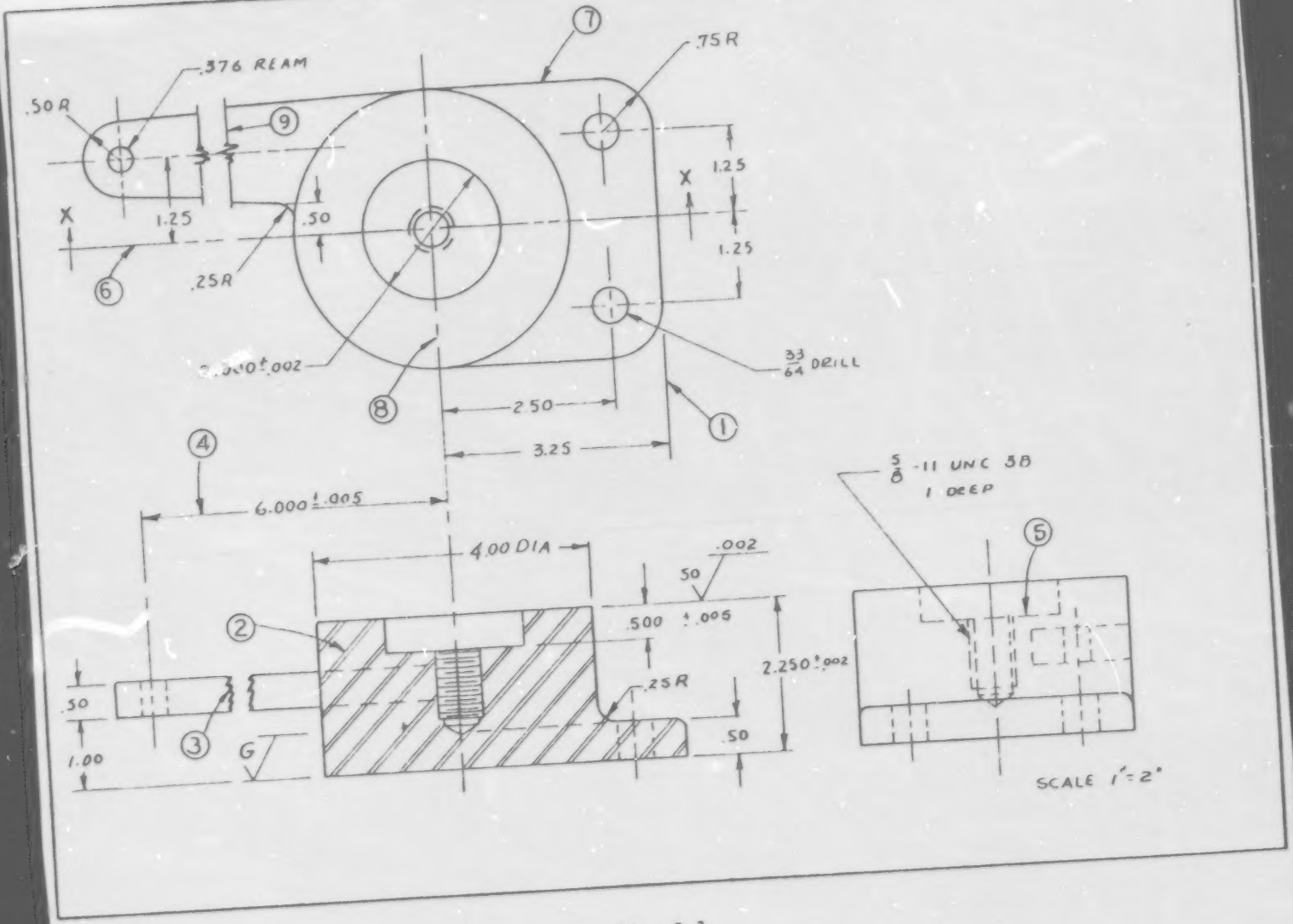

Fig. G-1

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The third part of a working drawing is comprised of symbols and notes. Fig. G-2 shows some of the more commonly used symbols. It is not the intent of this module to list all of the metal trades symbols but they are used to denote the roughness or smoothness of the ground piece, the thread measurements if the piece is to be connected by bolts, or screws, and the type of material to be used.

The more commonly used materials in machine and welding trades include the following:

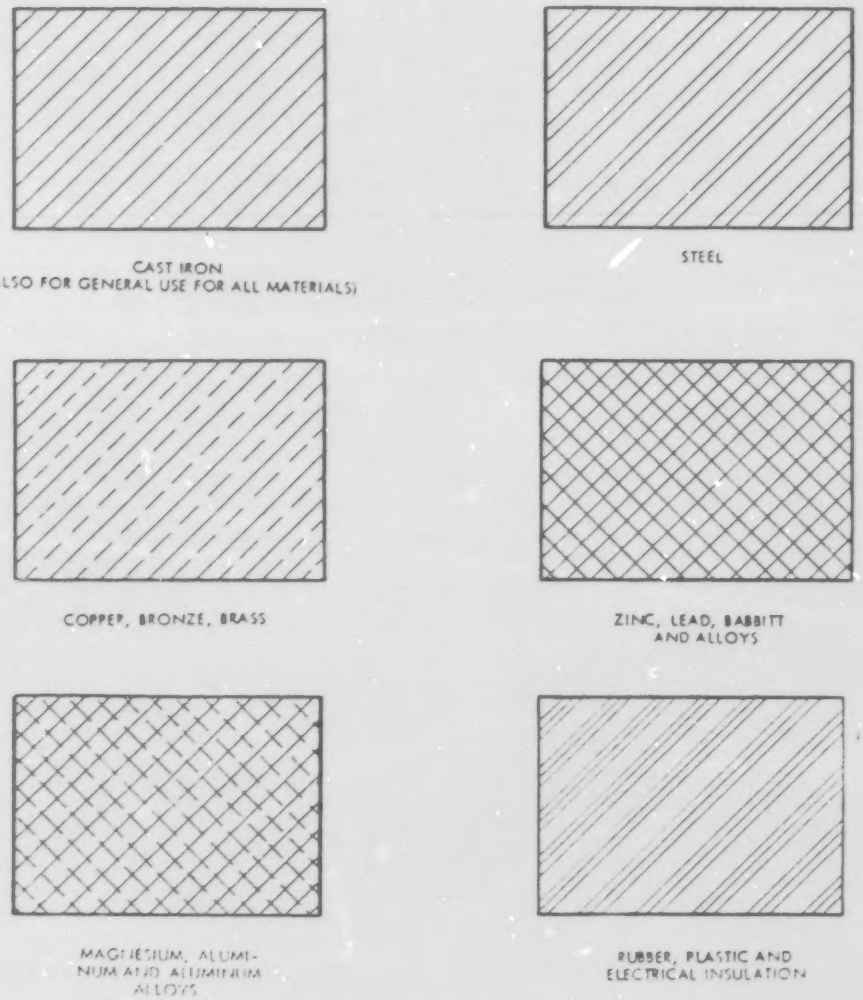

CAST IRON
(ALSO FOR GENERAL USE FOR ALL MATERIALS)
STEEL
COPPER, BRONZE, BRASS
ZINC, LEAD, BABBITT AND ALLOYS
MAGNESIUM, ALUMINUM AND ALUMINUM ALLOYS
RUBBER, PLASTIC AND ELECTRICAL INSULATION

Fig. G-2

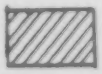
Self Assessment

Complete the following statements by filling in the correct word or words.

1. Working drawings must show the shpae and _____ of an object by using object and _____ lines.

2. A tolerance of 1/100 of an inch too large or too small would be shown on a working drawing as _____.

3. The dimension which uses minutes and seconds is _____.

4. The material symbol  would represent the use of which metal?
_____

5. The lines on working drawings which have arrowheads are _____ lines.

SELF ASSESSMENT ANSWER SHEET

1. size, dimension

2. ± .001

3. angular

4. cast iron

5. dimension

Post Assessment

Referring to Fig. G-1 in the Information section of this module in which the different types of lines are lables by circles numbers, describe what is represented by the following numbers:

1. extension line

2. steel

3. short break line

4. dimension line

5. hidden line

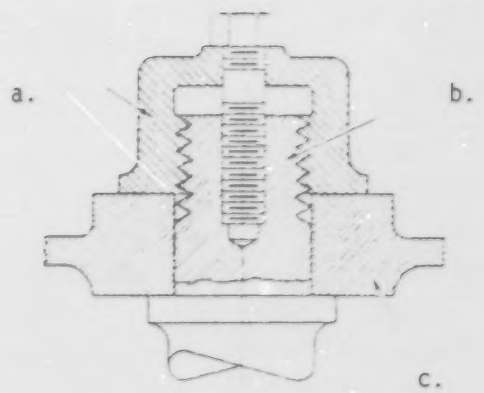
6. center line

7. object line

8. center line

9. long break line

10. Using the following small diagram, decide what material is being called for:
    a.
    b.
    c.



INDIVIDUALIZED LEARNING SYSTEMS

5.5

MACHINE AND WELDING SYMBOLS

Goal:

Upon completing this module the student will be familiar with the common working drawing symbols used to denote metal finish work and welds, and how they are presented on a working drawing.

Performance Indicators:

The student will demonstrate knowledge in the subject by successfully completing a Self Assessment and a Post Assessment exam.

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Study Guide

In order to successfully complete this module, do the following tasks in the order in which they are presented. Check them off as you complete them.

1. ____ Familiarize yourself with the Goal and Performance Indicators presented on the cover of this module. This will inform you of what you are expected to gain from the study of this module, as well as how you will be expected to demonstrate your competence.

2. ____ Study the Information section. This will provide you with the knowledge necessary to complete the Self and Post Assessment exams.

3. ____ Complete the Self Assessment exam, referring to the Information section or asking your instructor when necessary. Compare your answers with those found on the Self Assessment Answer Sheet immediately following the exam. This will demonstrate how well you can expect to do on the Post Assessment exam.

4. ____ Take the Post Assessment exam and turn your answers in to your instructor for grading. It is recommended that you score 90 percent or better before going on to another module.

Information

The fifth module of this section, "Working Drawings for Machining and Welding," explained that three elements are found in working drawings: lines, dimensions and symbols or notes. That module discussed lines and dimensions as they apply to the machine and metal trades; this module will discuss the symbols and notes.

MACHINE SYMBOLS

Machined materials most often must be ground to a desired degree of smoothness or roughness in order to meet the specifications called for by the draftsperson.

Surface finish symbols are as follows:

✓ or V = smooth finish, with the following letters placed in the V

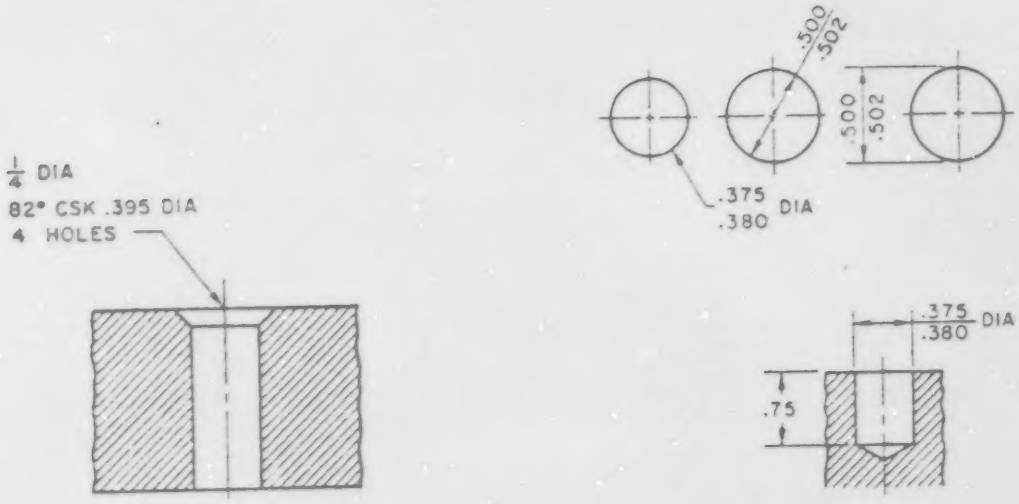
R = rough machining

S = smooth machining

G = ground surface

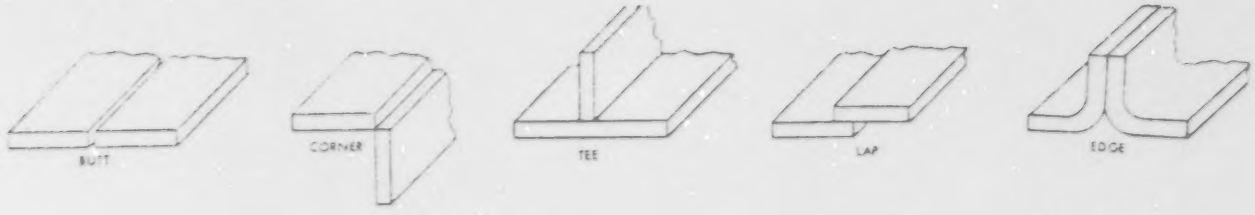
When the surface is to be more exactly controlled than simply a rough or smooth designation, the check mark (✓) with a number placed in it is used. The number refers to the microinches (or millioniths of an inch) of roughness height. An example: 55✓ , means that the machined surface can have flaws of only 55/1,000,000 in height or depth.

In addition to surfaces, holes for keys, bolts and screws must also be specified in many machined parts. Several typical hole drawings and dimensions are shown below in figure H-1.



WELDING SYMBOLS

There are two important factors which welding symbols provide. First, the symbols point out the type of weld to be made; secondly, they point out on what side or sides of a joint that particular type of weld is to be made. Figure H-2 illustrates the common types of weld joints.



Certain types of welds may be used on each of these basic joints. The common types of welds include seam, groove, flange, fillet, spot and others. Each of these types has its own specific symbol. The spot weld symbol is a circle: ○ ; the seam weld symbol is a circle with horizontal lines through it: ⊖ ; the fillet weld symbol is a right triangle: ◺ ; and so on. It is not the intention here to present all of them; seek complete information from this module's Supplementary Reference section.

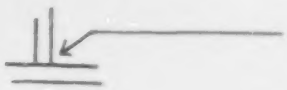
The second main factor in welding symbols, you will recall, is the symbol used to point out the location of the weld, or on which side of the joint the weld is to

be made.

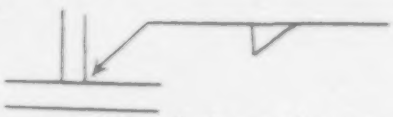
The main part of a welding symbol is the reference line with an arrow at one end.

Example:

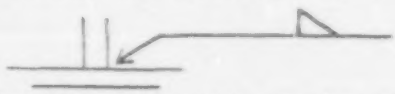
The location of the weld is pointed out by the arrow, like this:



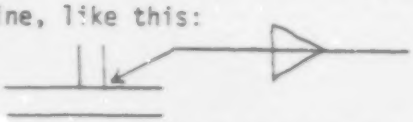
If the weld is to be made on only the side the arrow is pointing to, the appropriate weld symbol (in this instance, we'll assume it to be a fillet weld) will be placed below the reference line, like this:



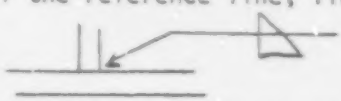
If the weld is to be made on the side opposite of where the arrow is pointing, the appropriate symbol will be placed above the reference line, like this:



If the weld is to be made on both sides, then the appropriate symbol will be placed both above and below the reference line, like this:



If it doesn't really matter on which side of the joint the weld is to be made, the symbol would be placed in the middle of the reference line, like this:



Obviously, there are many more symbols and numbers used on and along the reference line to point out spacing of welds, size of welds or weld combinations, etc. Consult the Supplementary Reference section for more complete information.

Self Assessment

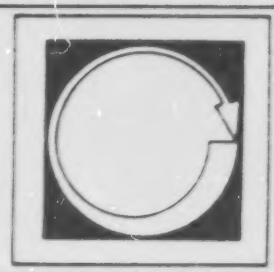
Decide if the following statements are true (T) or False (F) and place the appropriate letter in the space to the left of the statement.

1. ____ Machined materials never have finished surfaces.
2. ____ The term microinch refers to millionths of an inch.
3. ____ The symbol $\sqrt{S}$ indicates a rough finish is desired.
4. ____ Bolt hole dimensions are seldom given, relying usually on the letters B, F, or D.
5. ____ There are about 1,500,000 common weld joints.
6. ____ A lap joint refers to the fact that one piece overlaps another.
7. ____ The symbol for a spot weld is a circle.
8. ____ Welding symbols are different from all other symbols in that welding symbols have arrows on both ends of the reference line.
9. ____ The positioning of the welding symbol with respect to the reference line indicates where the weld is to be located.
10. ____ A butt joint means that one piece will be welded at a 90 degree angle to another piece.

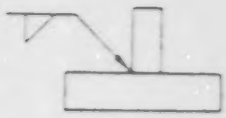
SELF ASSESSMENT ANSWER SHEET

1. F
2. T
3. F
4. F
5. F
6. T
7. T
8. F
9. T
10. F

Post Assessment



1. What does this weld symbol indicate? _____



2. Sketch the correct symbol for a seam weld.

3. The symbol

means that the surface must be machine smooth to a tolerance of 55 _____.

4. The main part of a welding symbol consists of a _____ and an arrow.

5. The letters R, S and G mean as follows:

   R =

   S =

   G =

5.6

BLUEPRINT READING

Drafting: Basic Print Reading

Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
2. Relate two dimensional drawings to three dimensional objects.
3. Utilize measurements and scales to interpret blueprints.
4. Identify the purpose and configuration of commonly used machine features.
5. Interpret notes on blueprints for dimensions and tolerances.

Introduction

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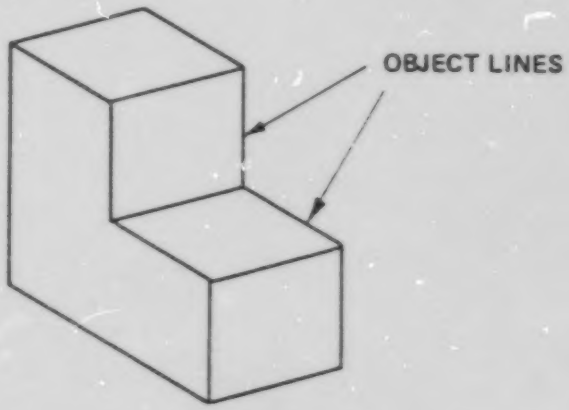

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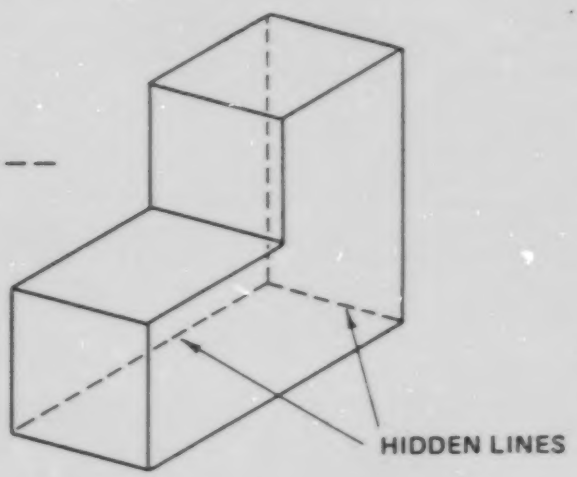

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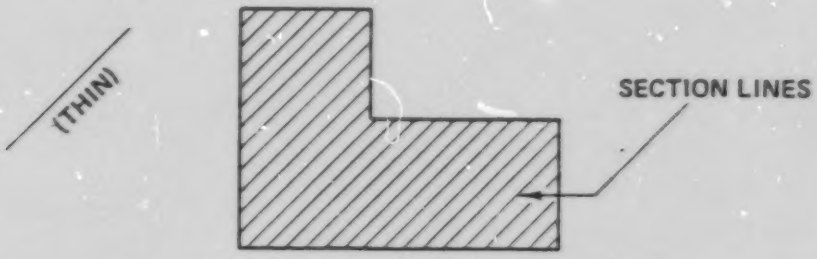

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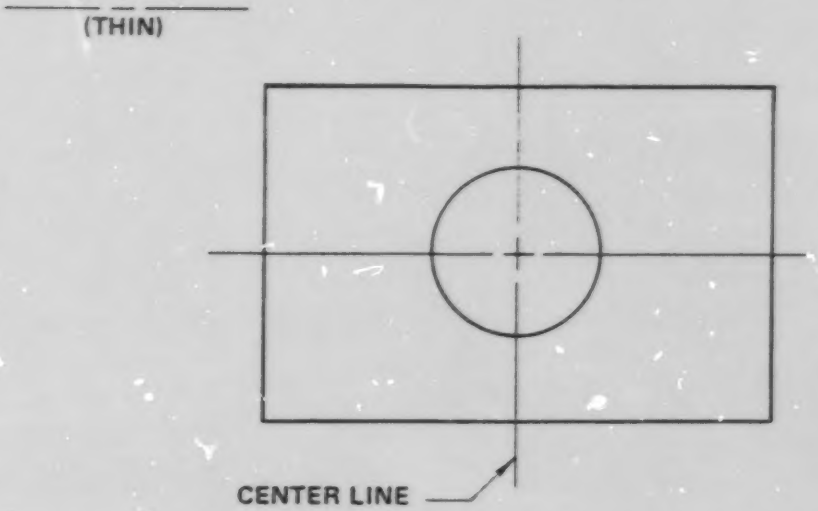

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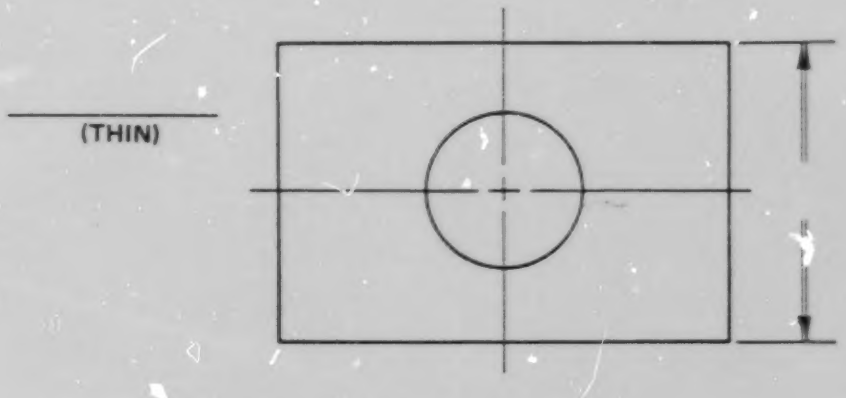

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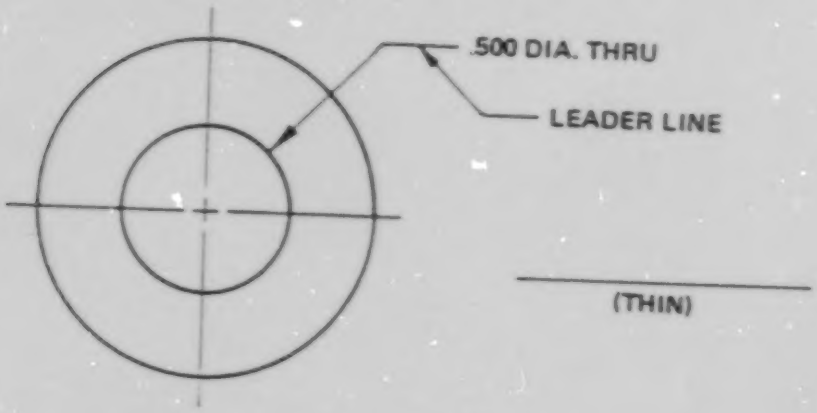

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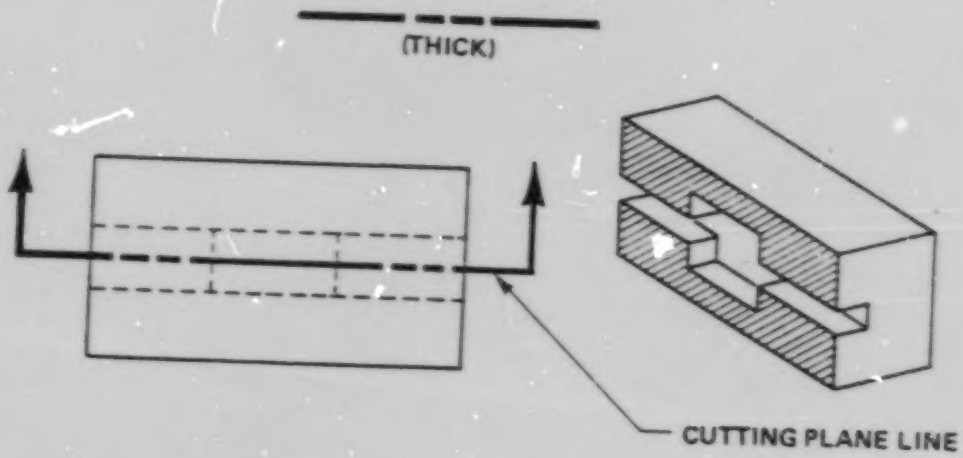

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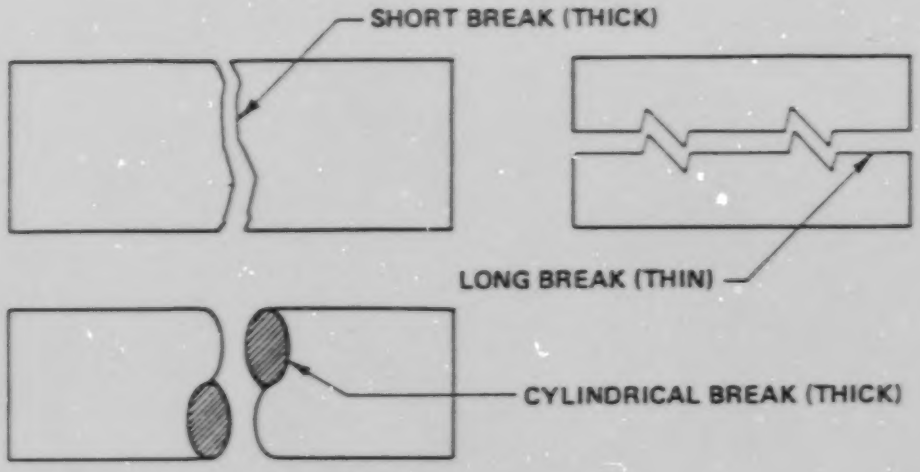

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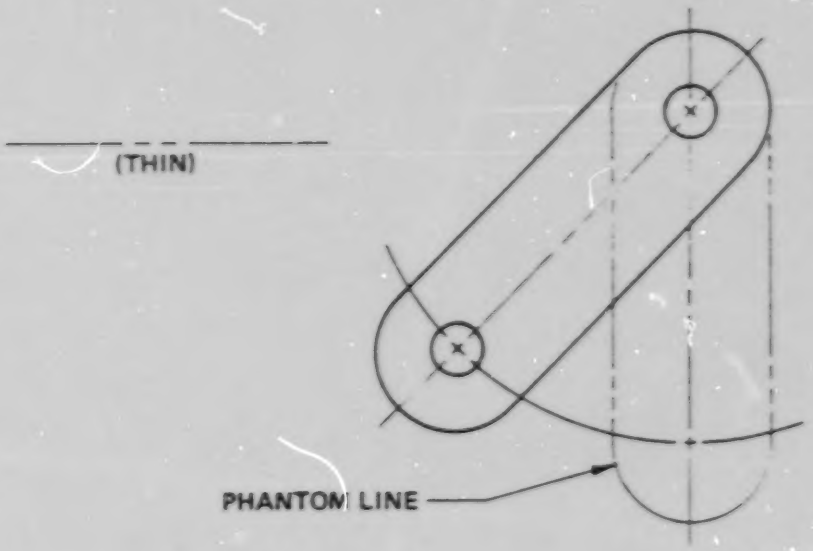

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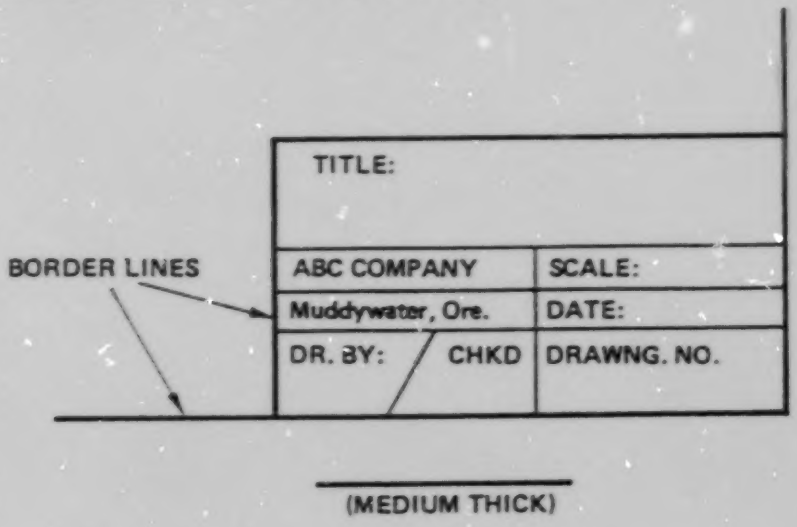

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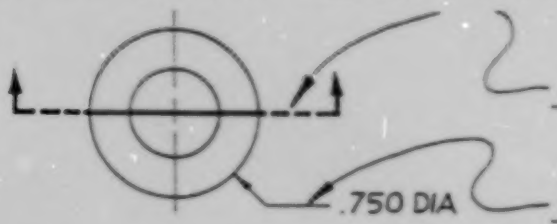

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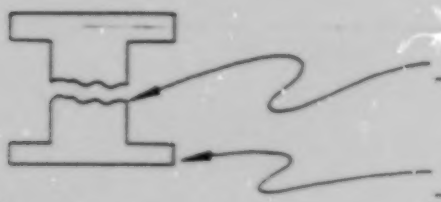

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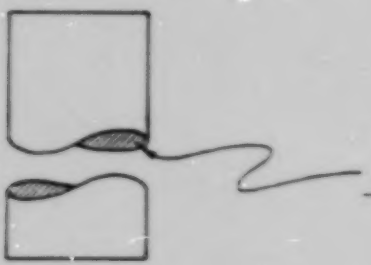

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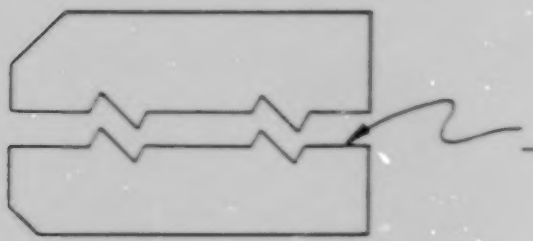

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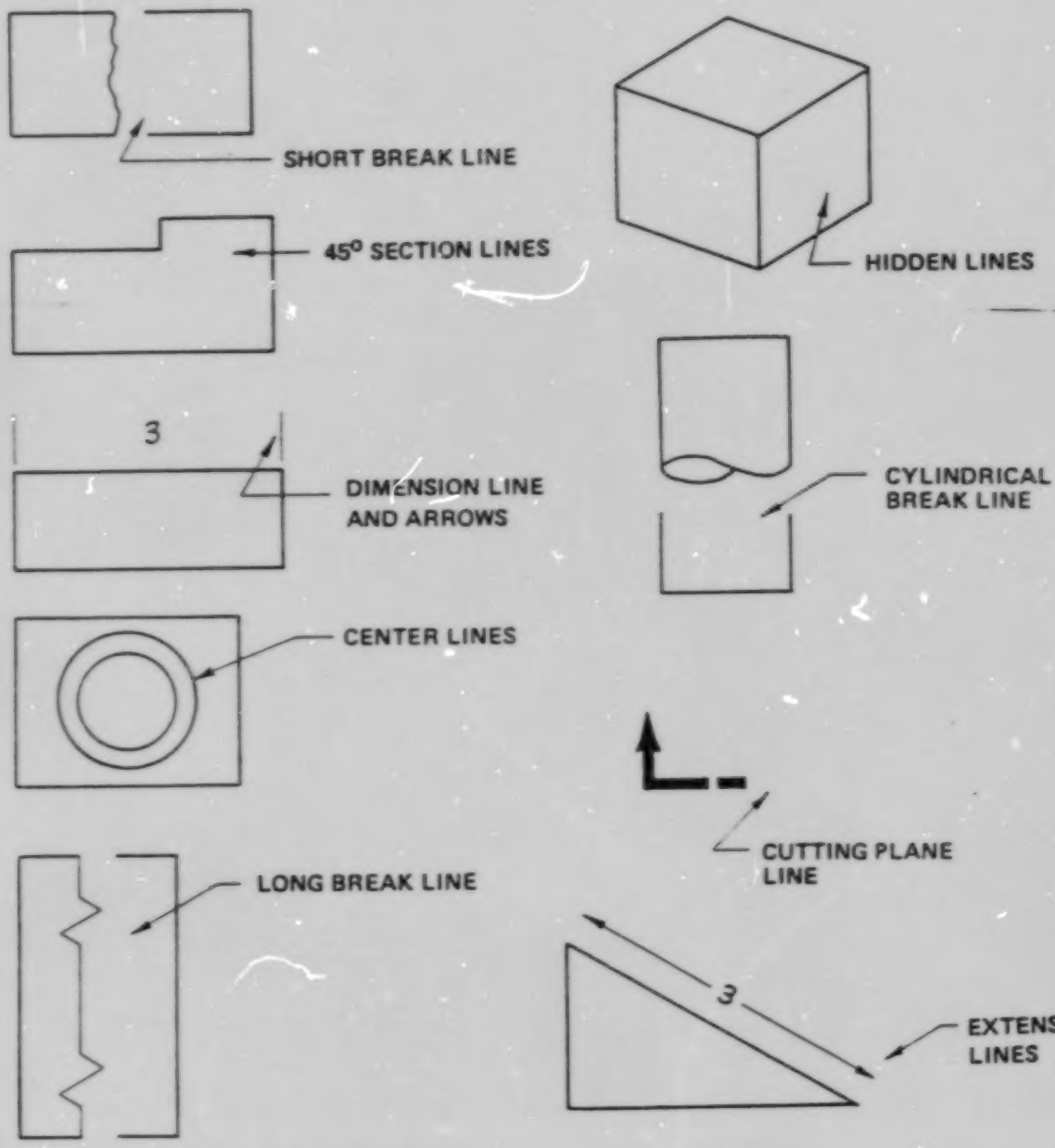

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Drafting: Basic Print Reading

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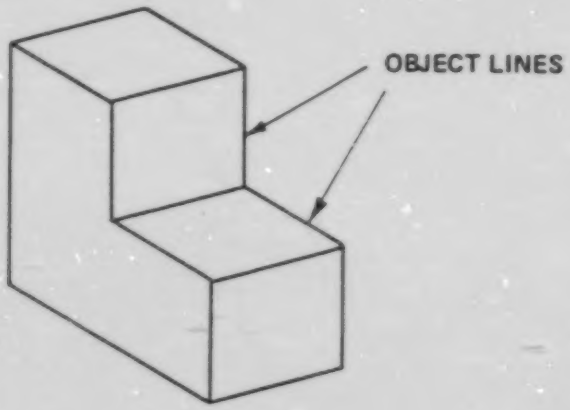

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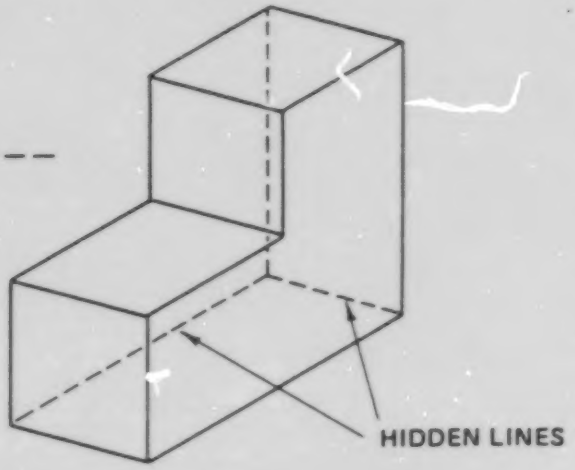

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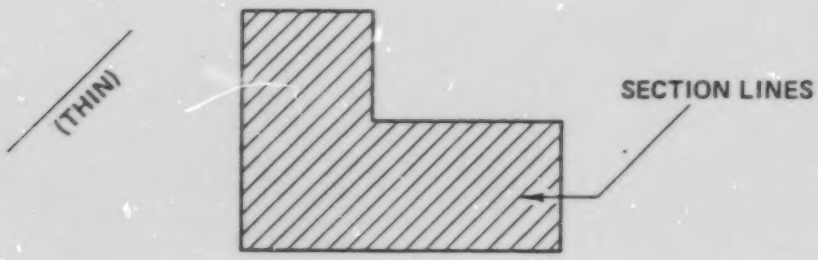

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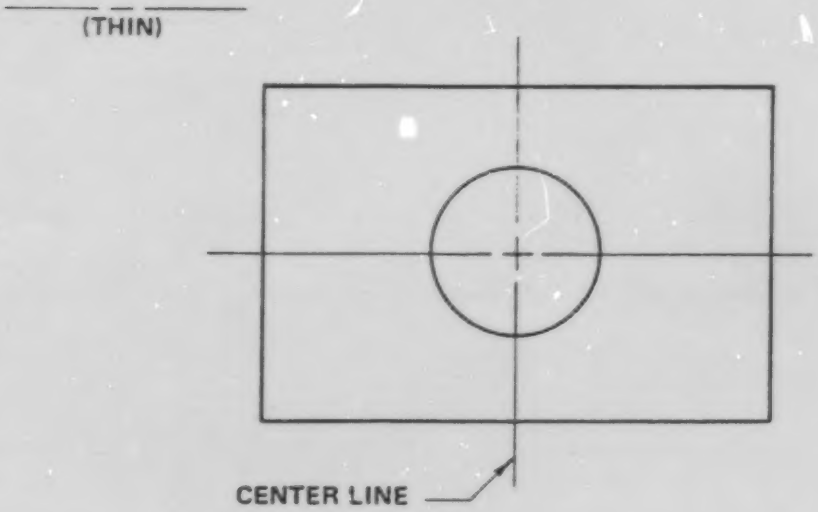

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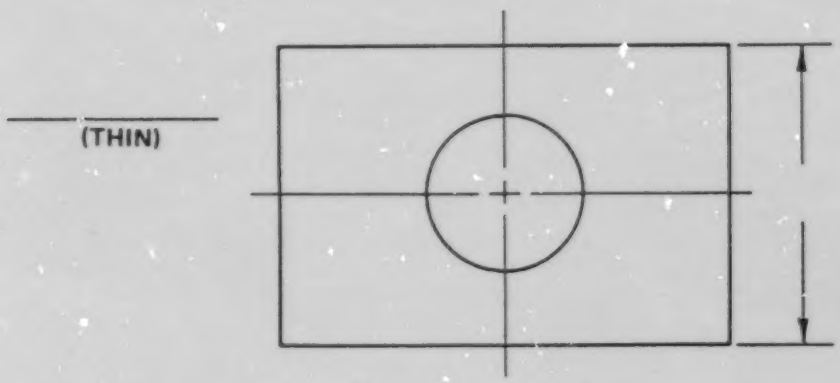

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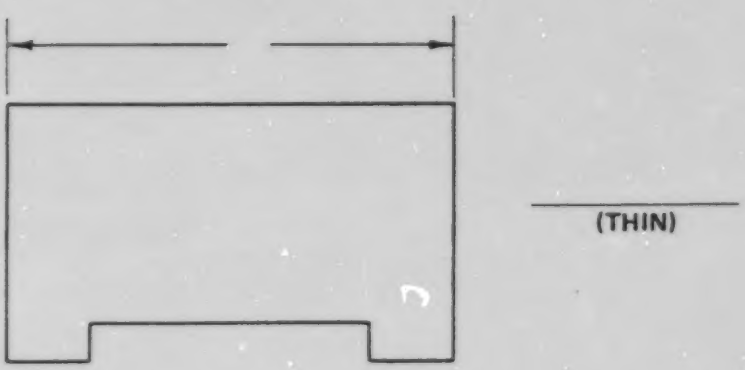

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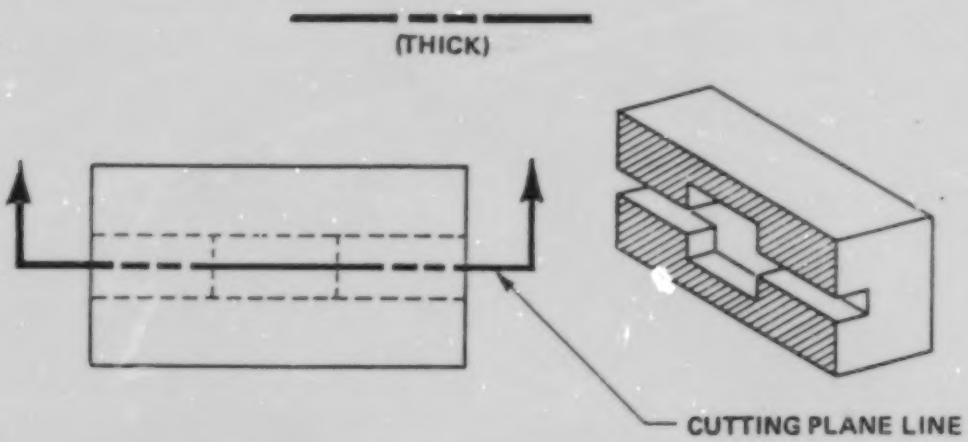

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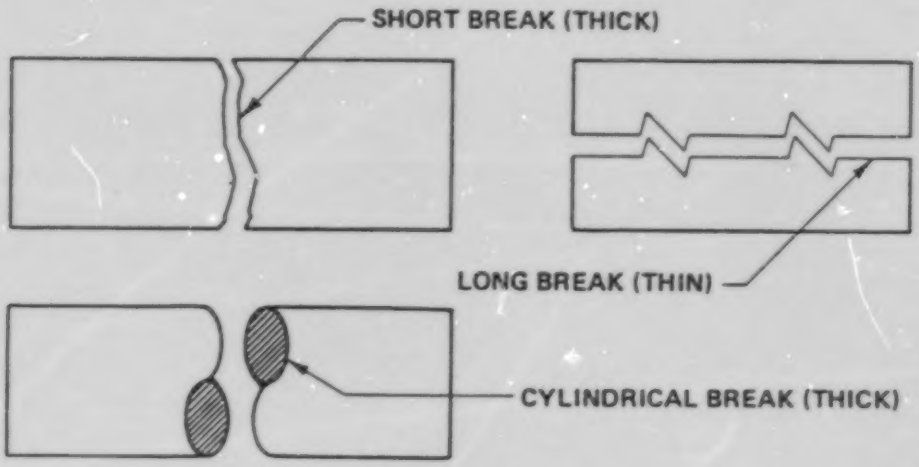

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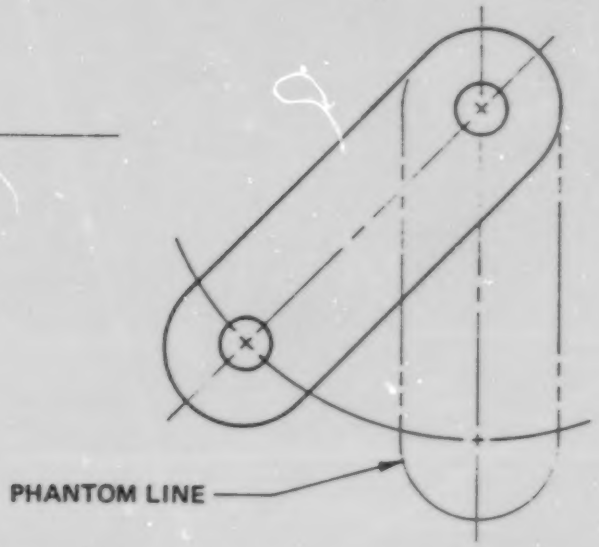

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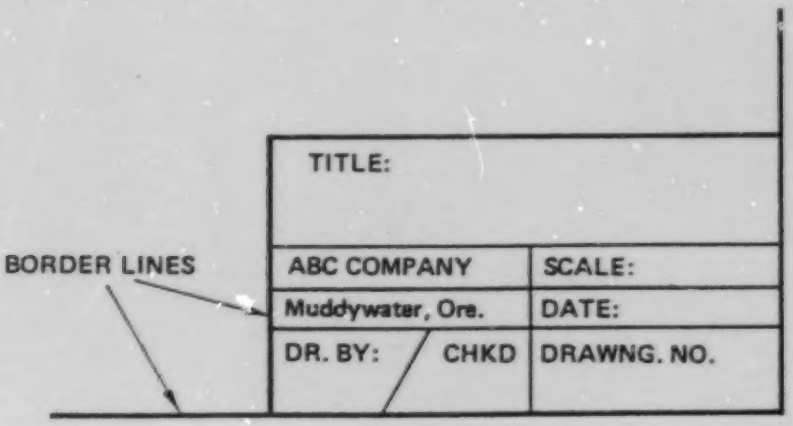

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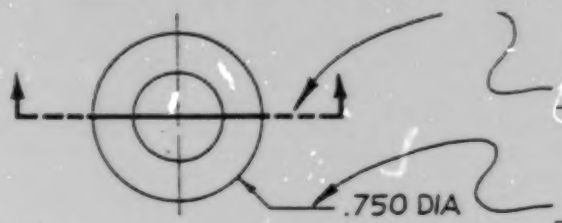

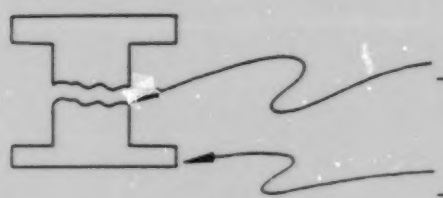

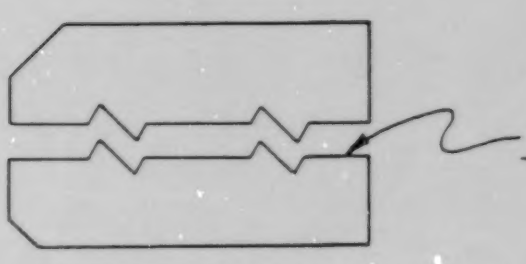

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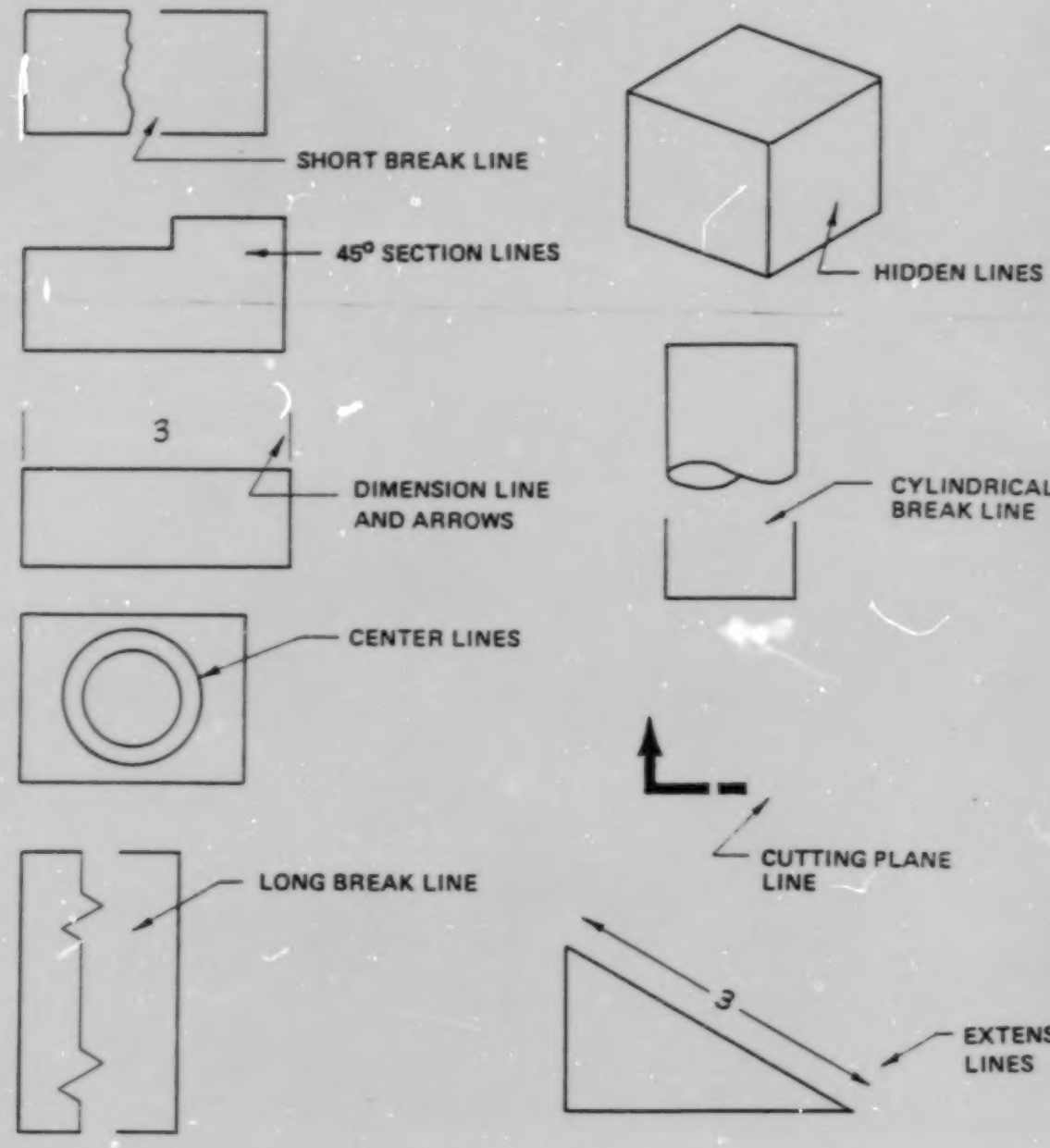

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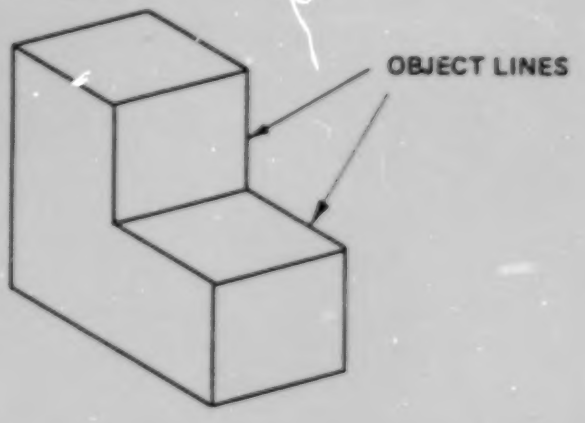

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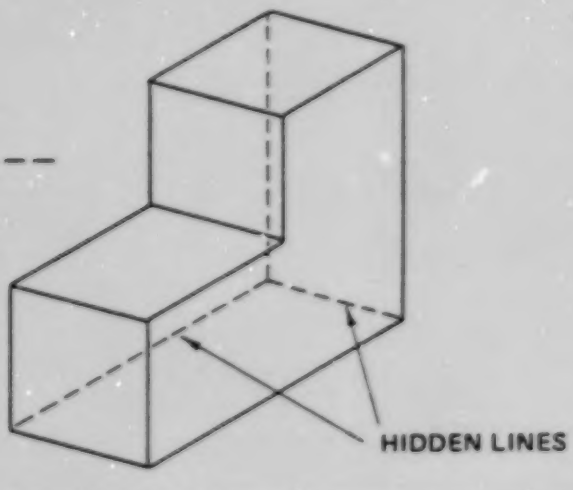

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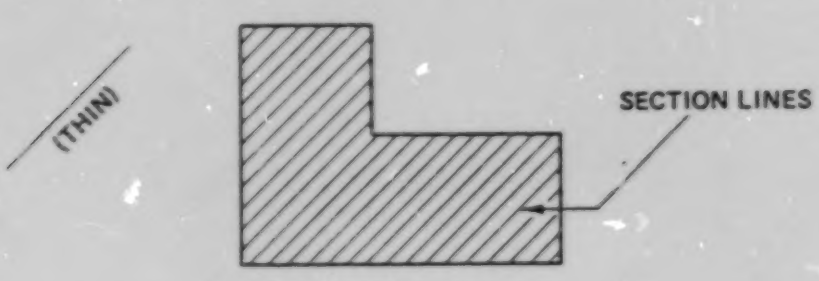

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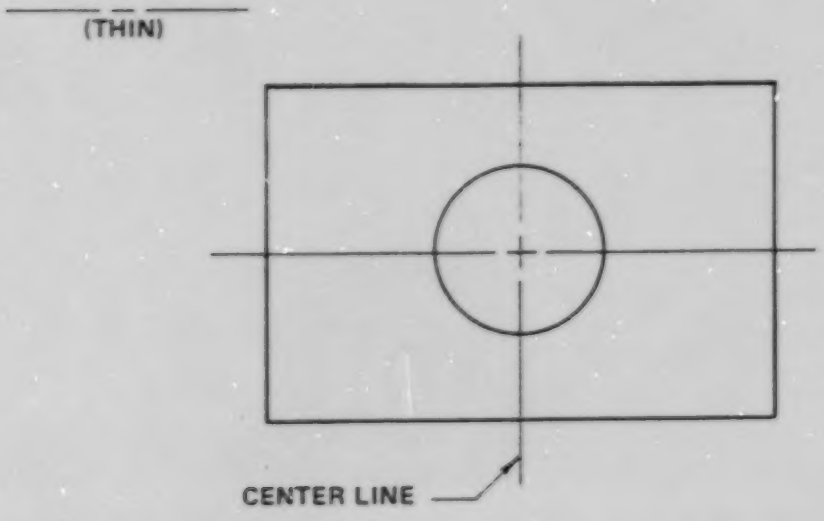

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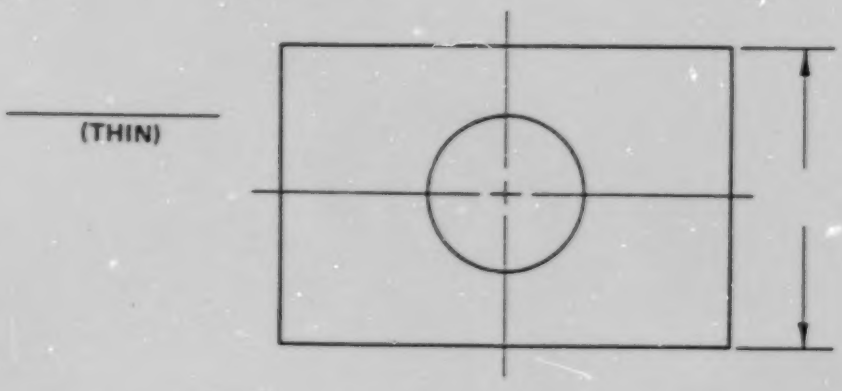

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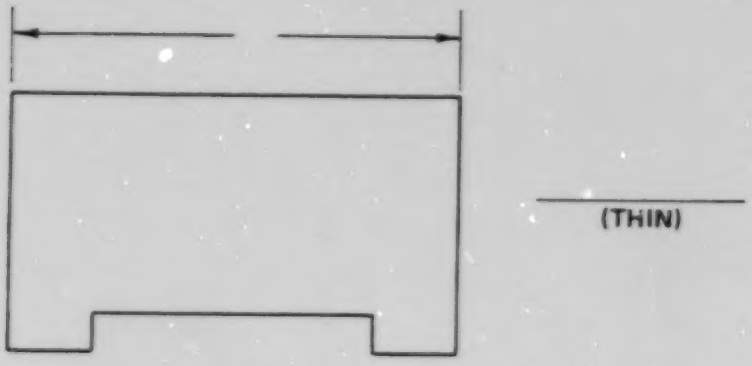

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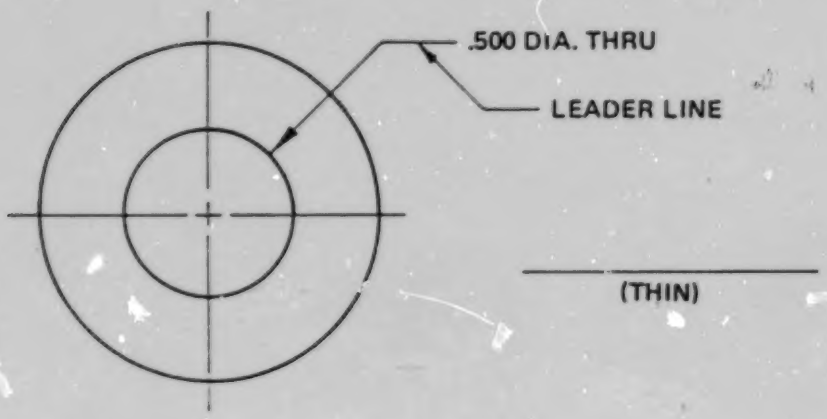

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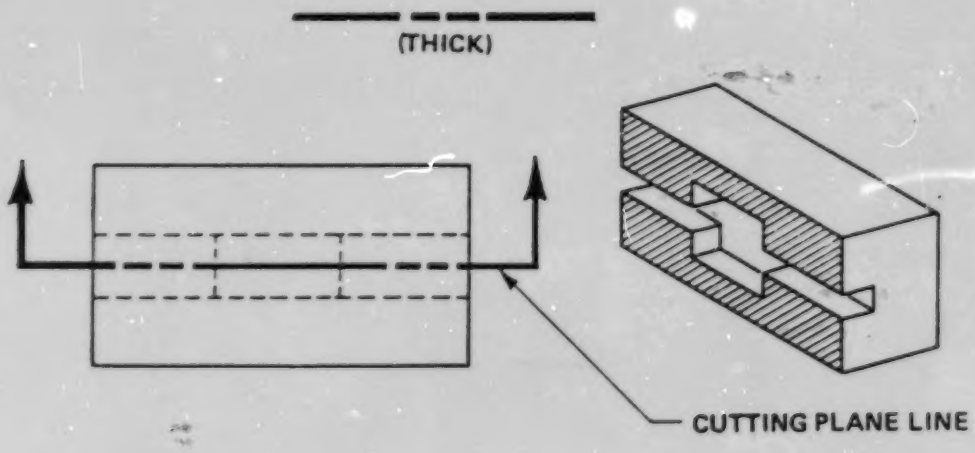

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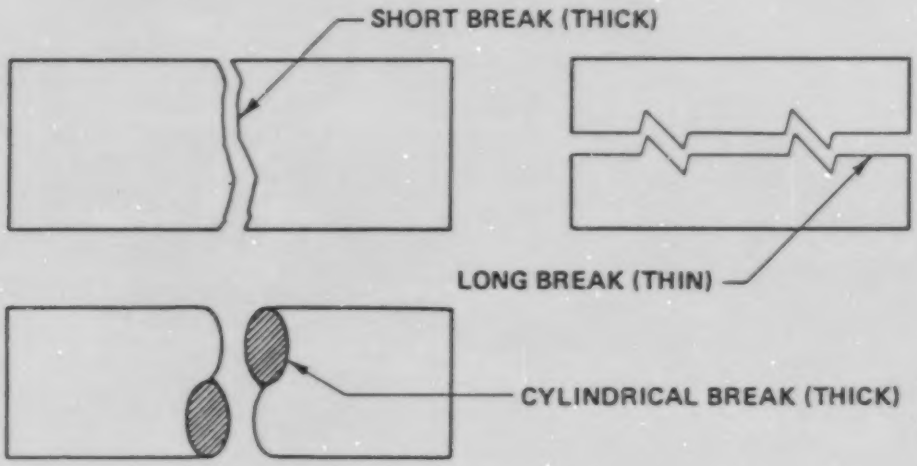

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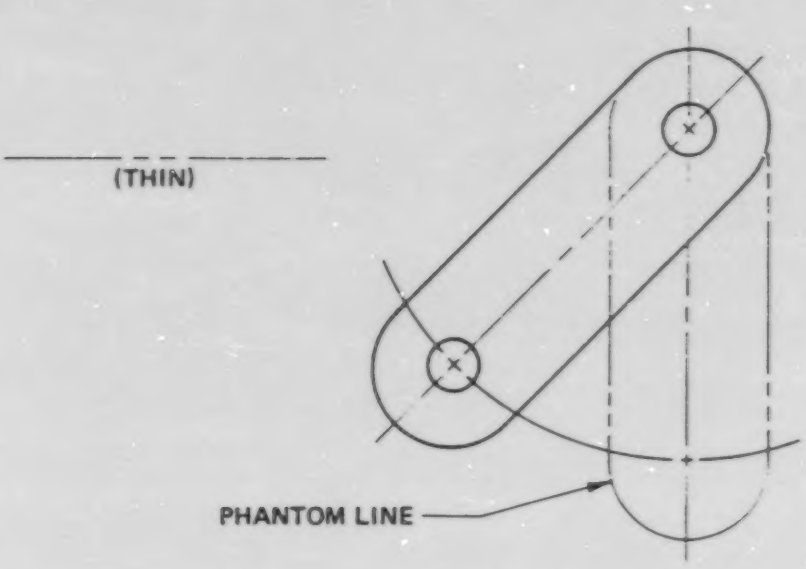

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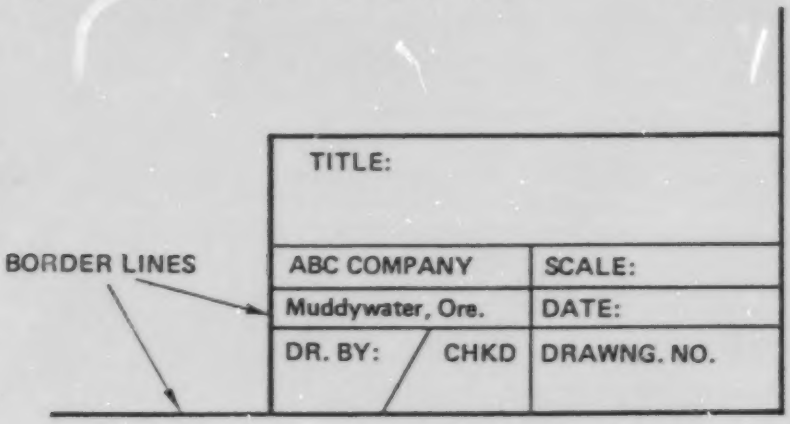
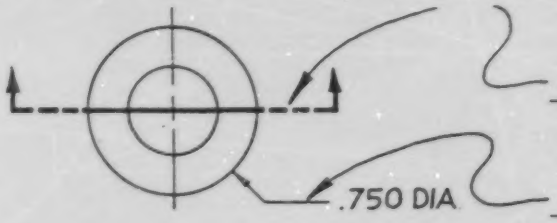


(MEDIUM THICK)

Self Assessment

Directions: Name the types of lines shown below. Check your own answers.



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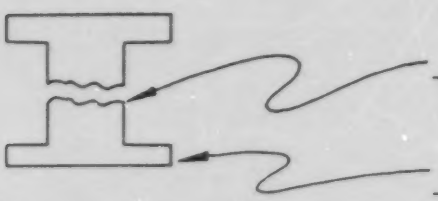

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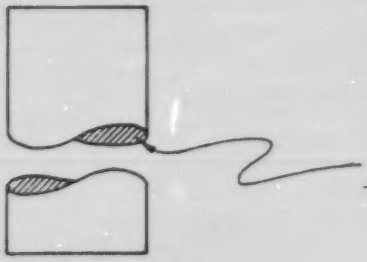

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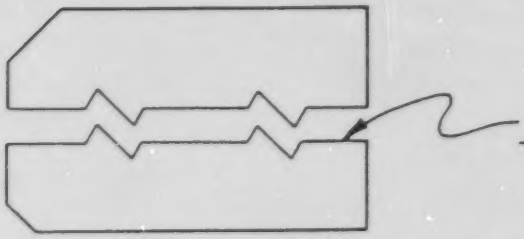

_____

Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
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LINE LANGUAGE REVIEW

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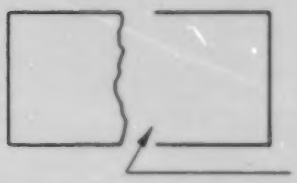

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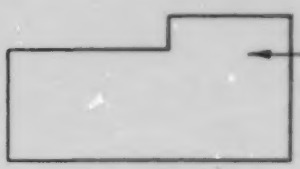
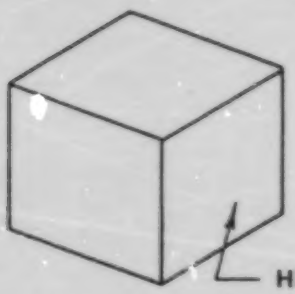


45° SECTION LINES



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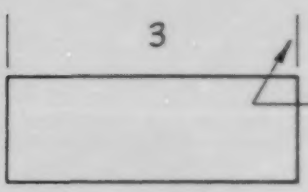

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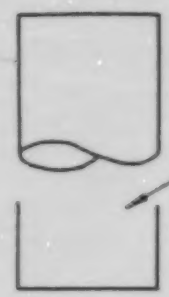

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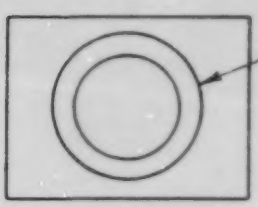

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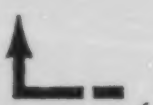
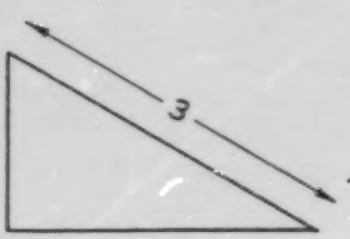


CUTTING PLANE LINE

LONG BREAK LINE



EXTENSION LINES

INSTRUCTIONAL LEARNING SYSTEMS

5.9

BLUEPRINT READING

Drafting: Basic Print Reading

Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
2. Relate two dimensional drawings to three dimensional objects.
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It is important to remember, as you study blueprint reading, that you are learning to communicate with the graphic language. Lines are part of the language.

Since technical drawings are made of lines, it is logical that the first step in learning to "read" a drawing is to learn the meaning of each kind of line. Generally, there are 11 basic types of lines. Each kind of line has a definite form and "weight." Weight refers to line thickness or width. When combined in a drawing, lines provide part of the information needed to understand the print.

Information

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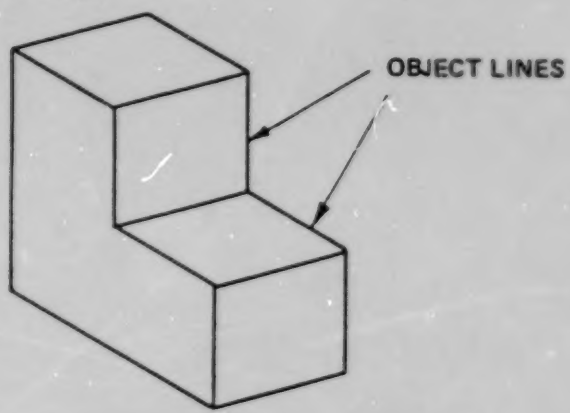
(THICK)



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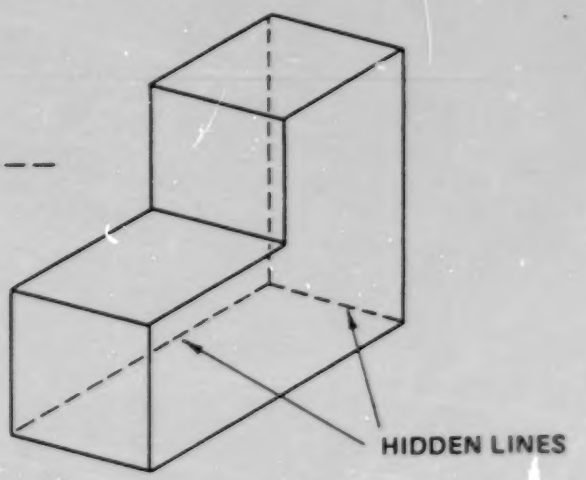
(MEDIUM)



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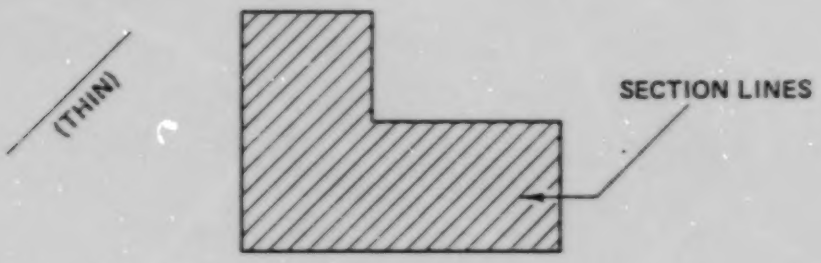

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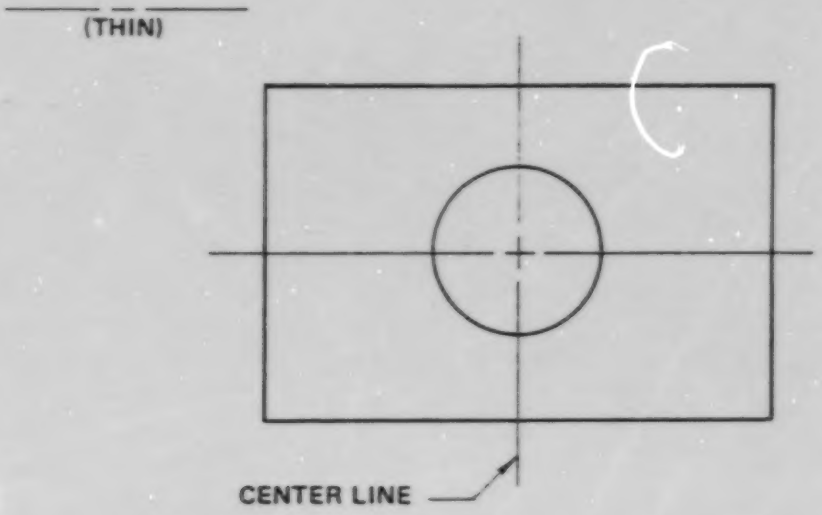

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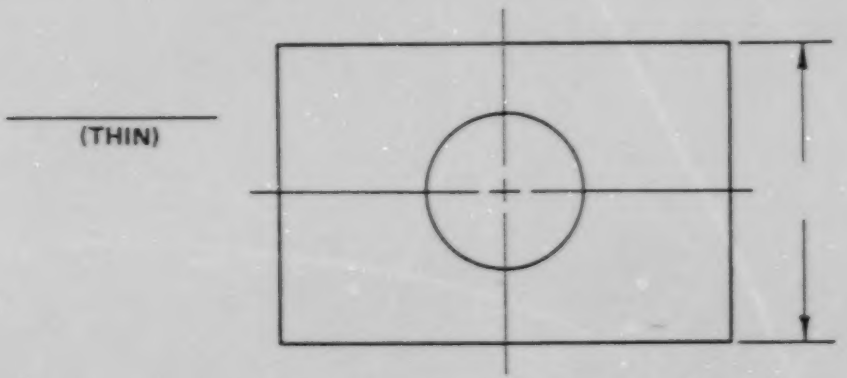

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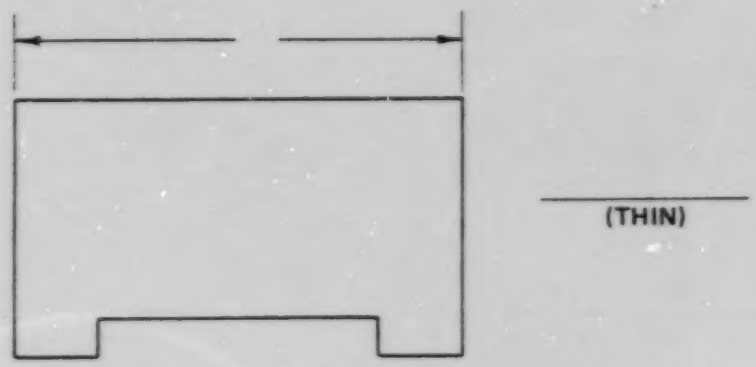

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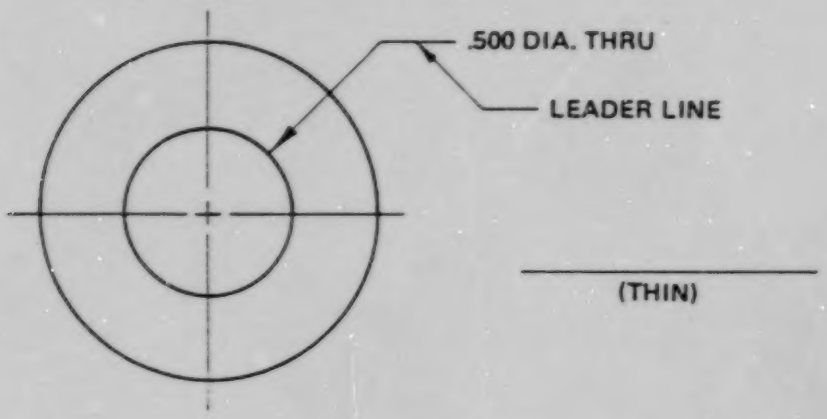
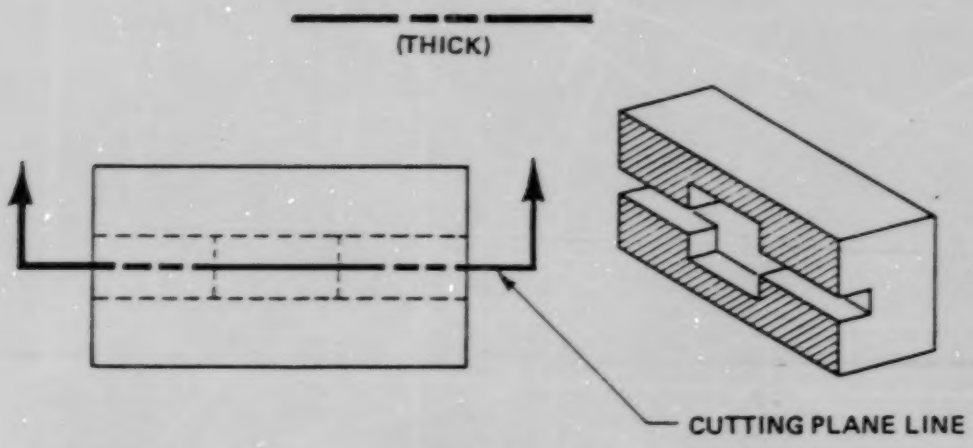


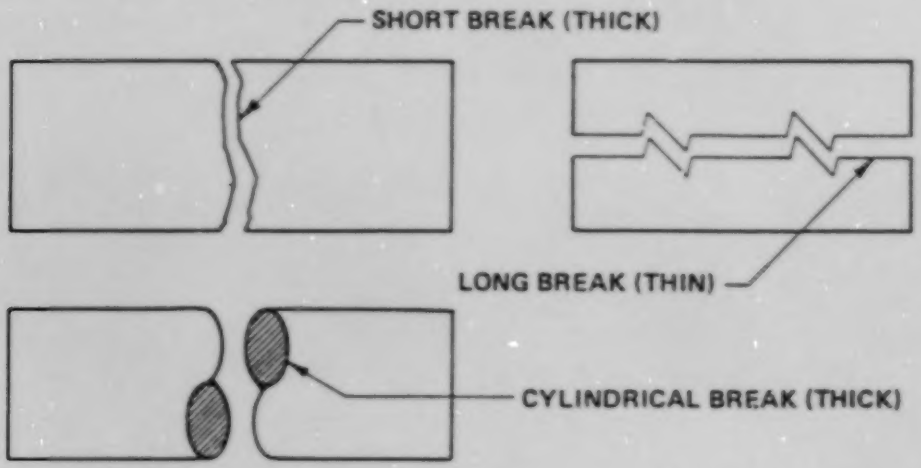
8. CUTTING PLANE LINE

A cutting place line (very heavy) helps to show a reference for sectioning. It is a line showing the plane where an imaginary cut is made to expose the internal shape of an object.



9. BREAK LINES (short, long, cylindrical)

There are three kinds of break lines used in drawings. They are used to remove or "break out" part of a drawing for clarity, and also to shorten objects which have the same shade throughout their length and may be too long to place on the drawing.



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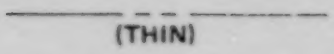

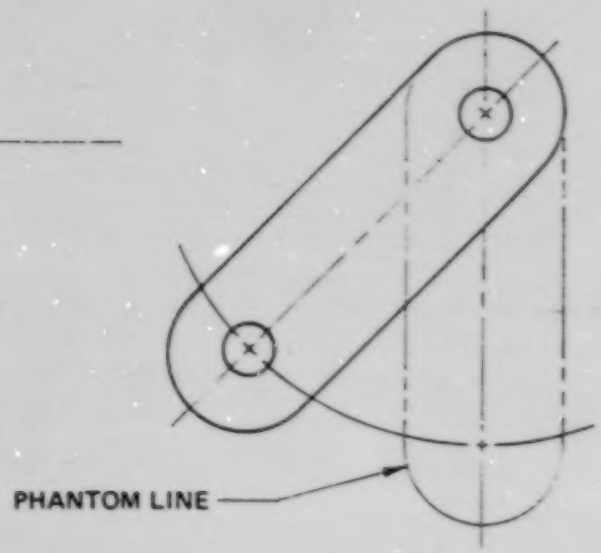

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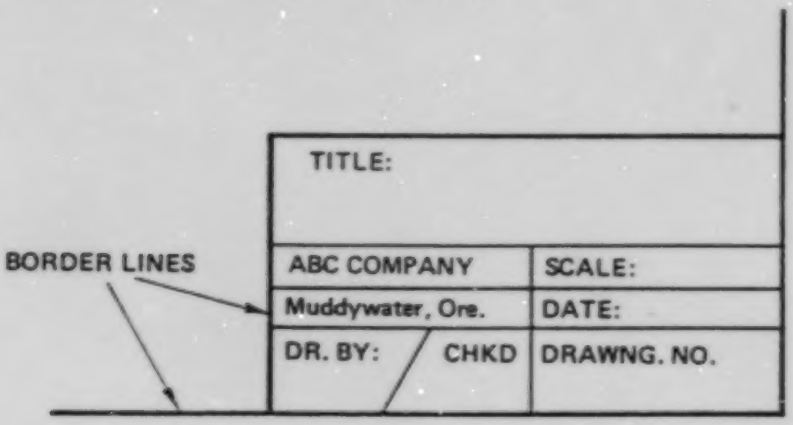

(MEDIUM THICK)

Self Assessment

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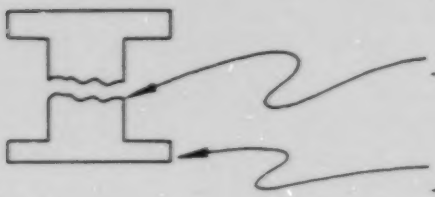

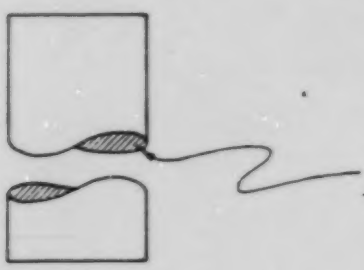

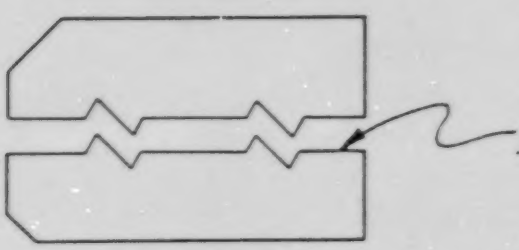

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4. Object line; 5. Extension line; 6. Cylindrical break;
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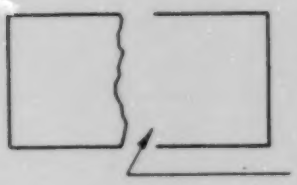
Directions: Draw the kinds of lines needed to complete the figures below.



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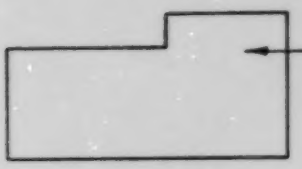

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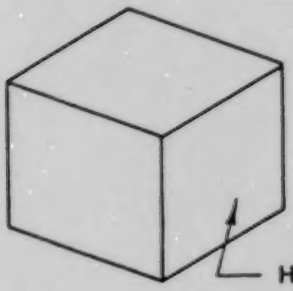

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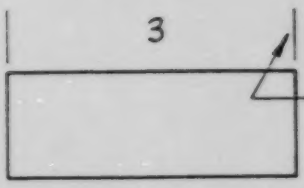

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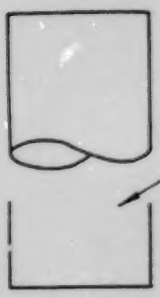

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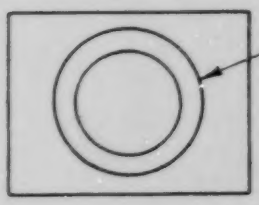

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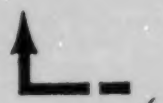

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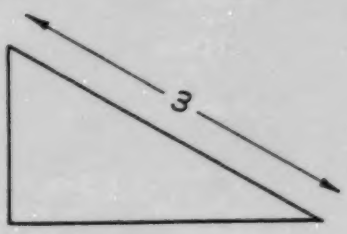

EXTENSION LINES

5.10

BLUEPRINT READING

Drafting: Basic Print Reading

Goal:

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Performance Indicators:

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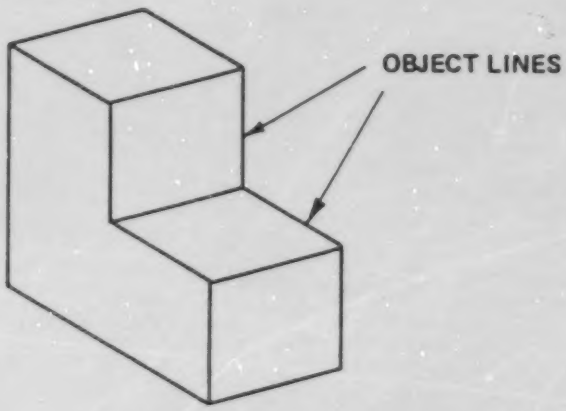

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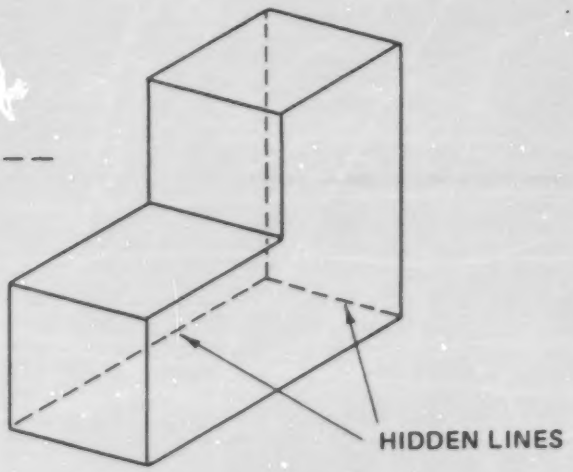

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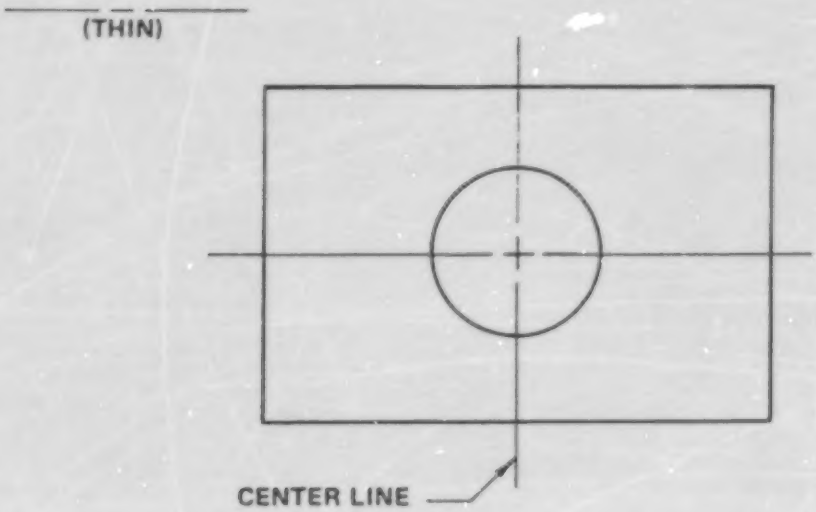

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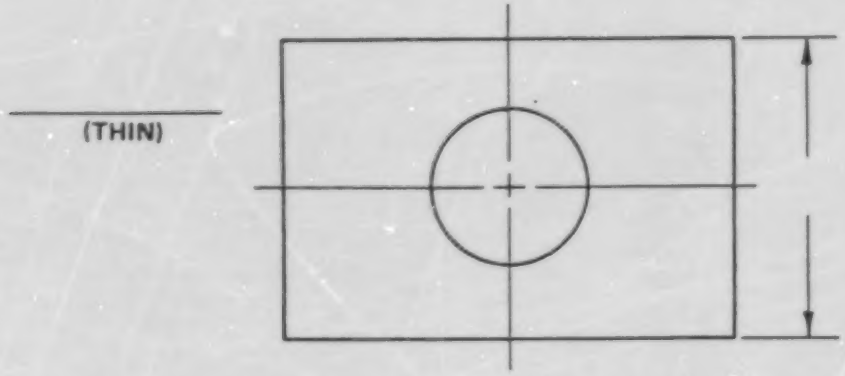

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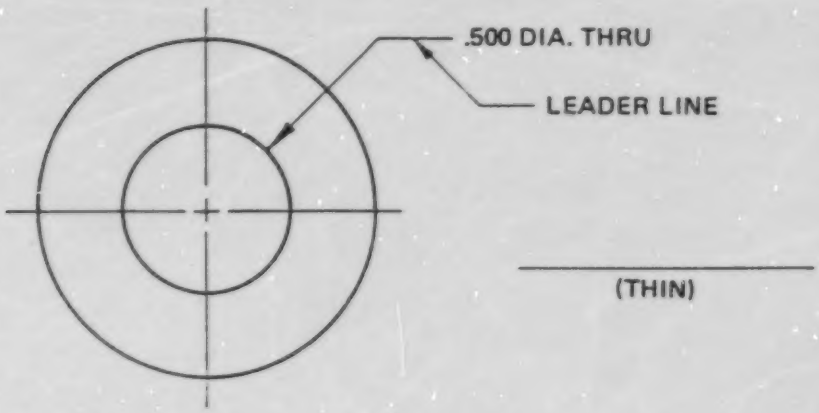

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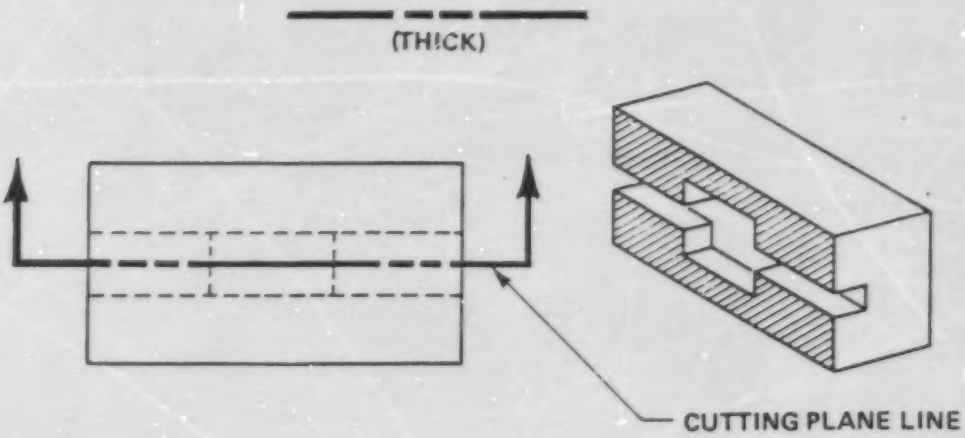

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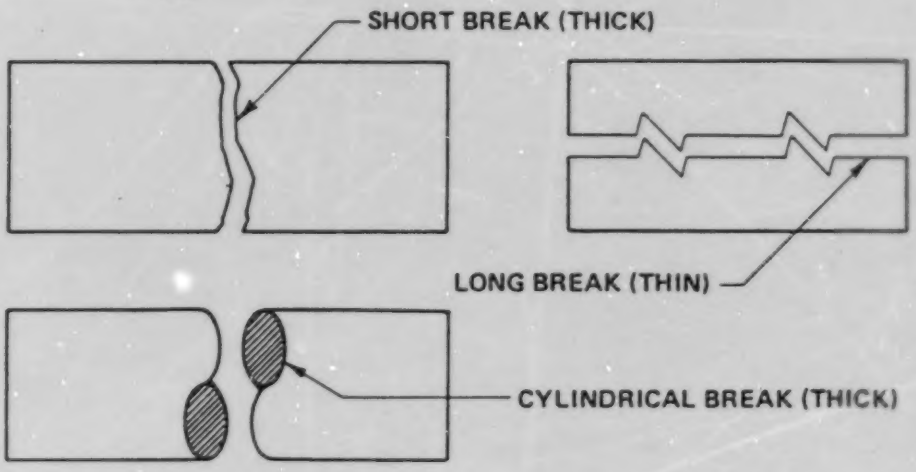

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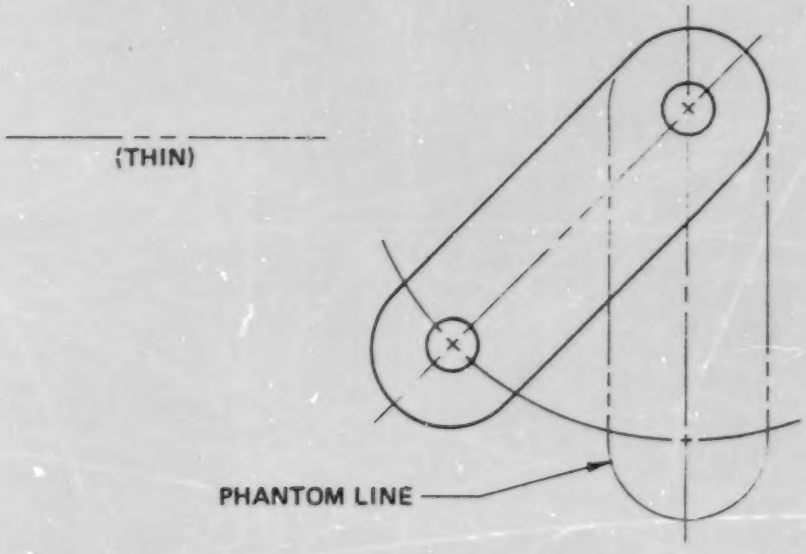

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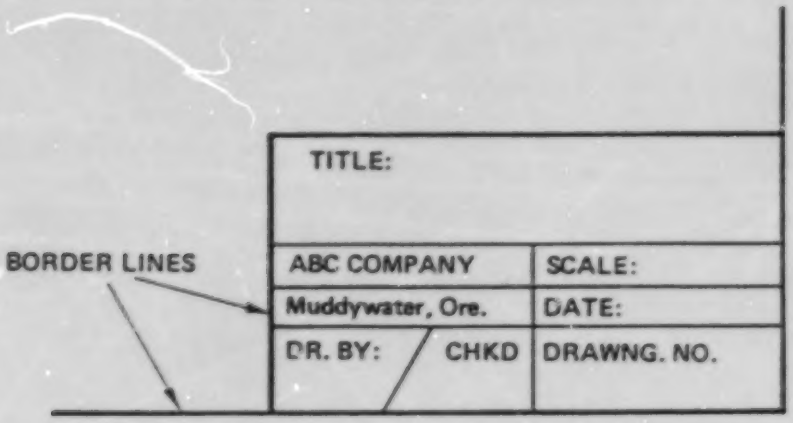
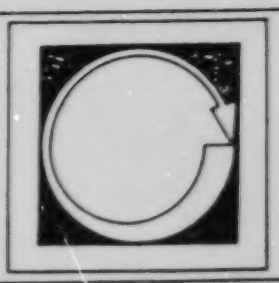


(MEDIUM THICK)

Self Assessment



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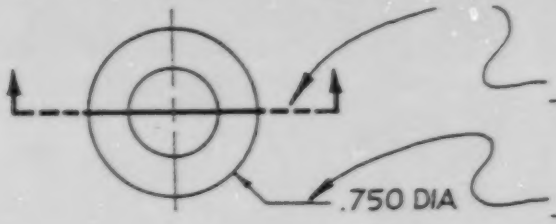

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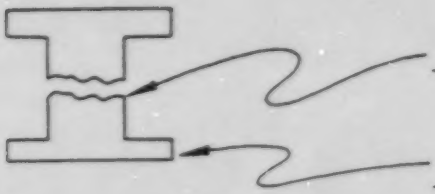

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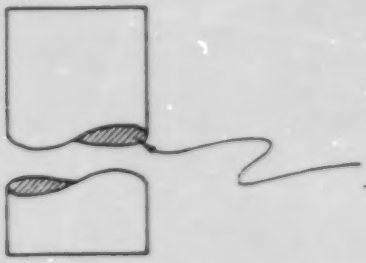

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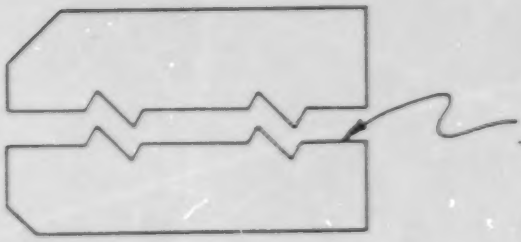

_____

Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
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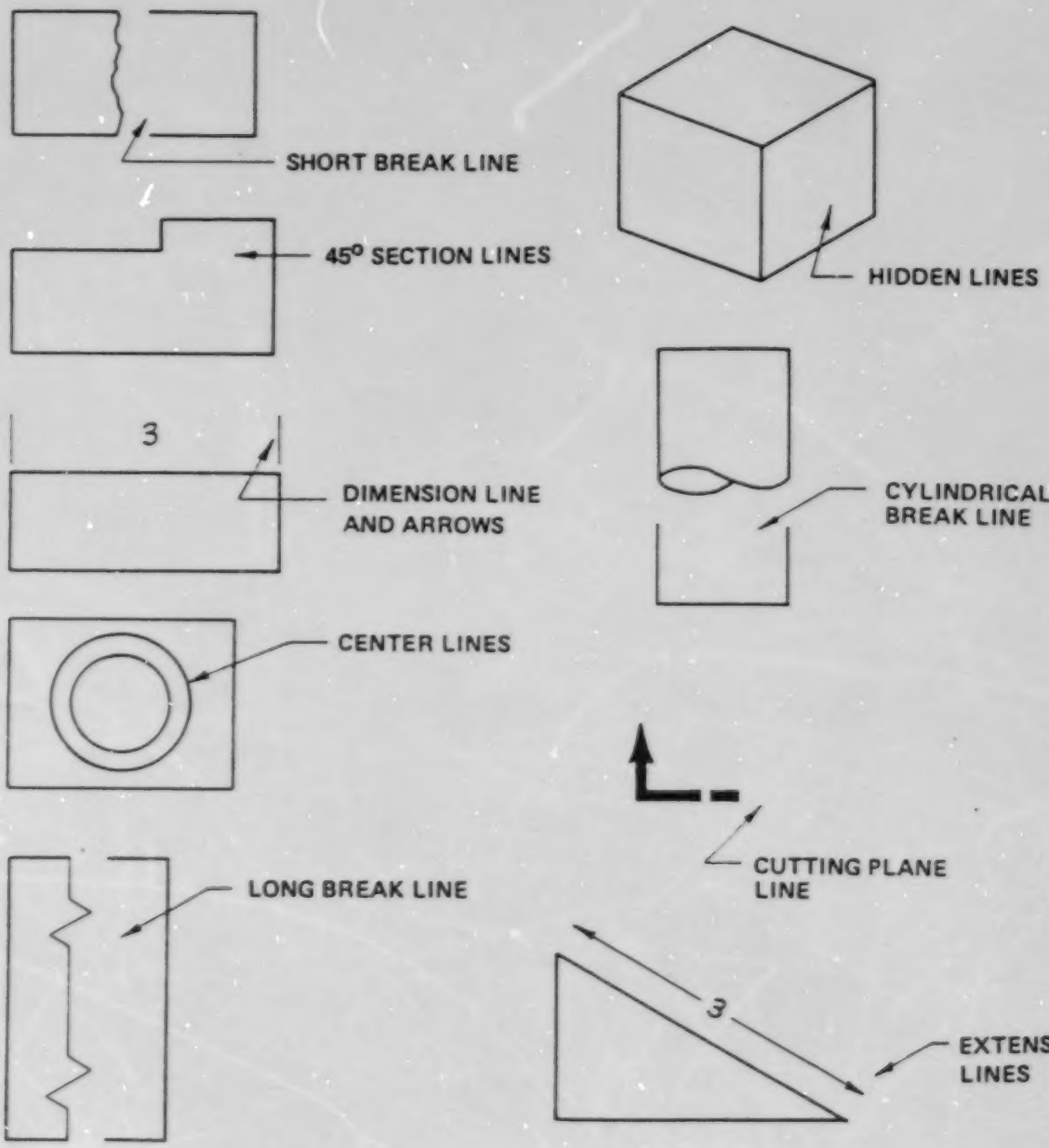
LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.



5.11

BLUEPRINT READING

Drafting: Basic Print Reading

Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
2. Relate two dimensional drawings to three dimensional objects.
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Introduction

You have heard the saying that "a picture is worth a thousand words." This statement is particularly true in regard to technical drawings.

It would be nearly impossible for an engineer, designer, or architect to describe in words the shape, size and relationship of a complex object. Therefore, drawings have become the universal language used by engineers, designers, technicians, and craftspeople to communicate the information necessary to build, assemble and service the products of industry.

It is important to remember, as you study blueprint reading, that you are learning to communicate with the graphic language. Lines are part of the language.

Since technical drawings are made of lines, it is logical that the first step in learning to "read" a drawing is to learn the meaning of each kind of line. Generally, there are 11 basic types of lines. Each kind of line has a definite form and "weight." Weight refers to line thickness or width. When combined in a drawing, lines provide part of the information needed to understand the print.

Information

The 11 lines used on prints are:

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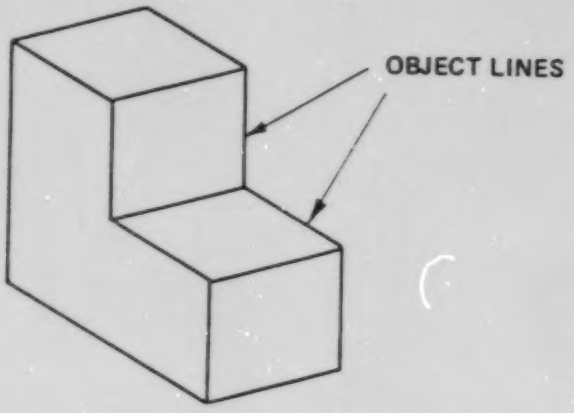
(THICK)



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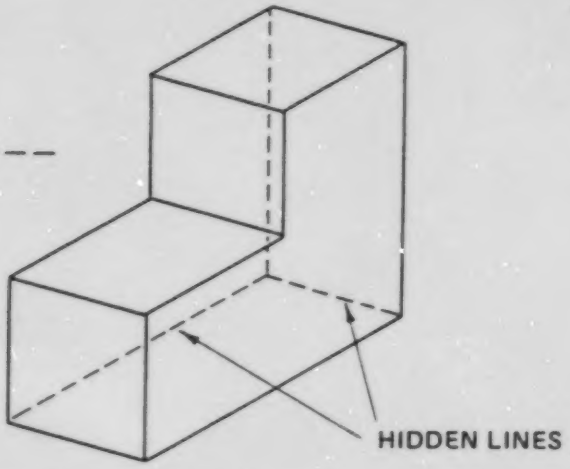
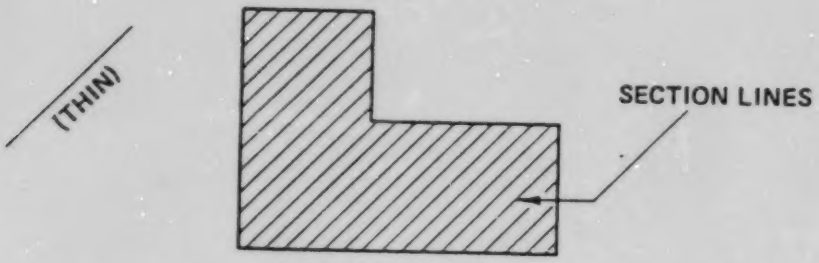
(MEDIUM)



3. SECTION LINE

Section lines are used on a drawing to show how it would look if it were sectioned, or cut apart, to give a better picture of shape or internal construction. Section lines are very thin, and are usually drawn at 45 degrees. They show the cut surface of an object in sectional view. More on sections will be explained later.



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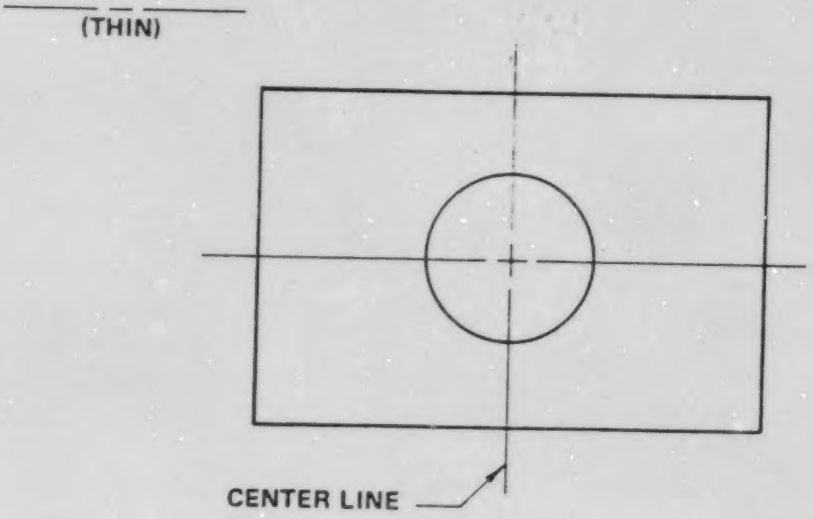

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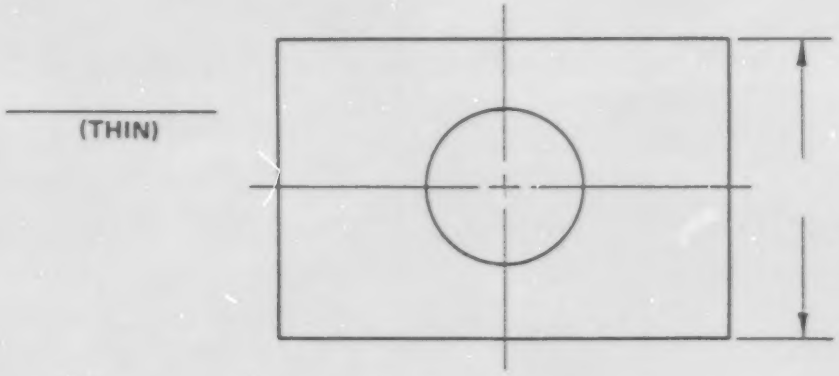

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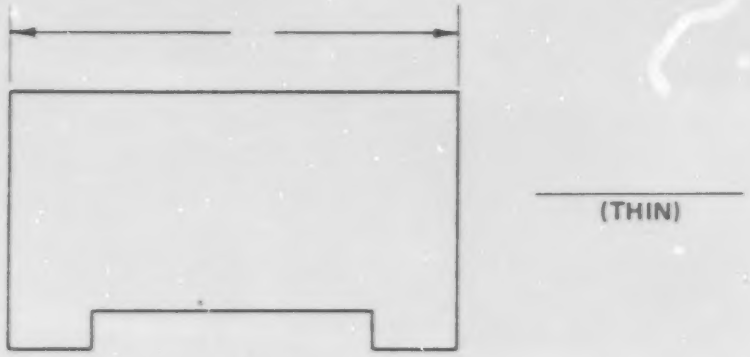

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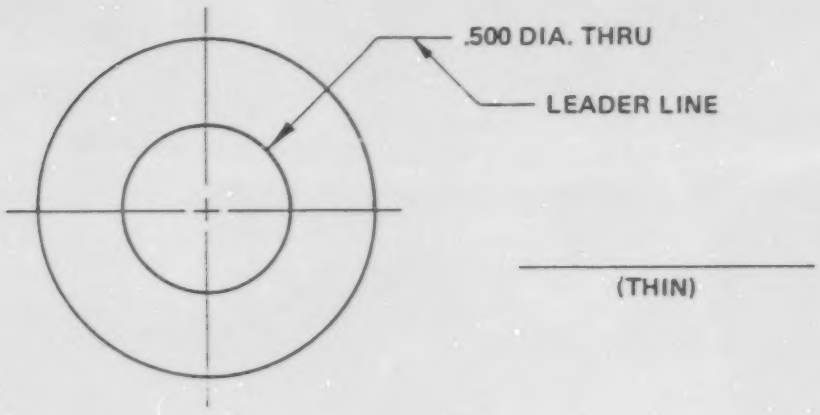

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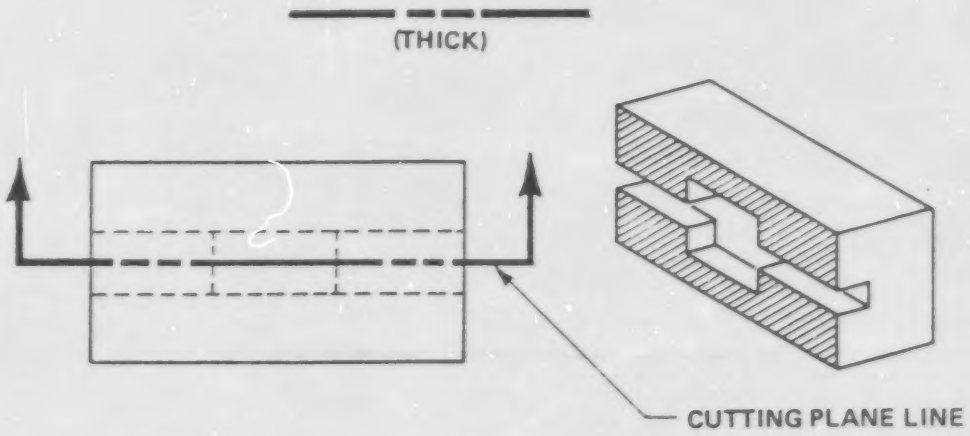

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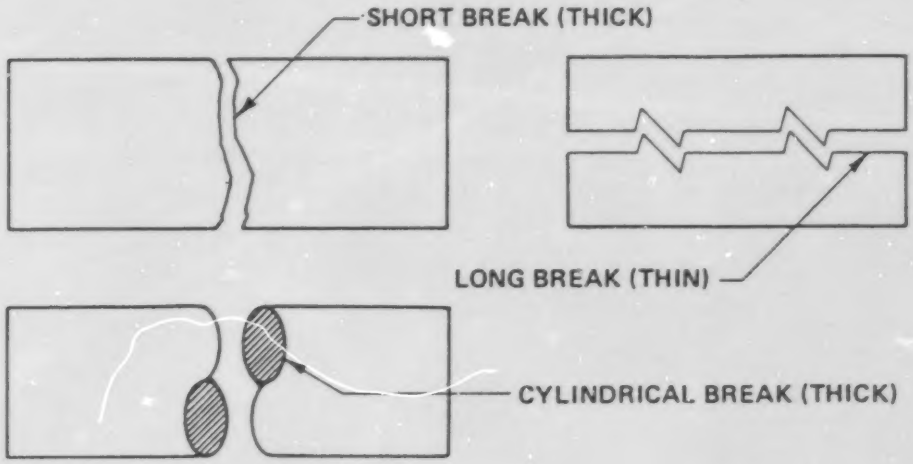

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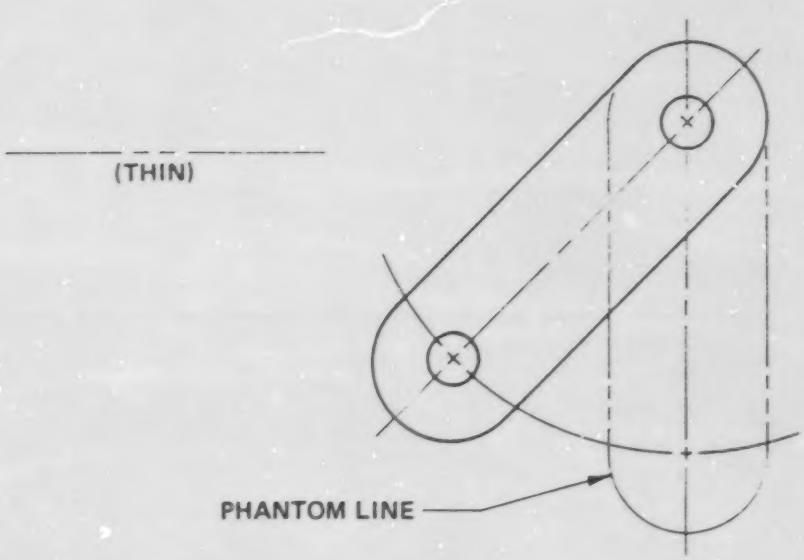

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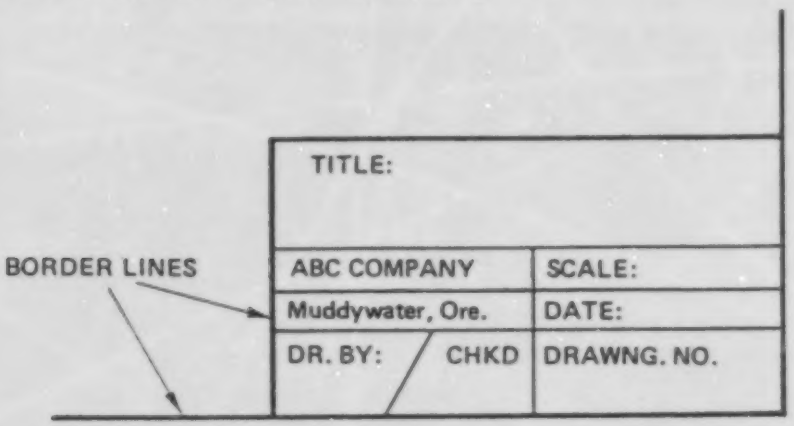

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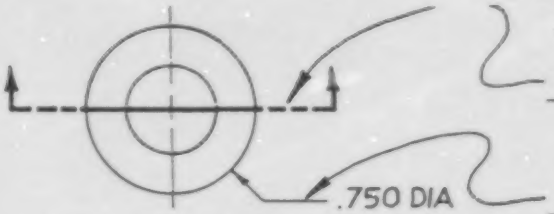

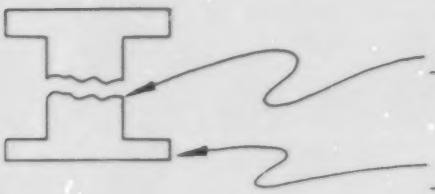

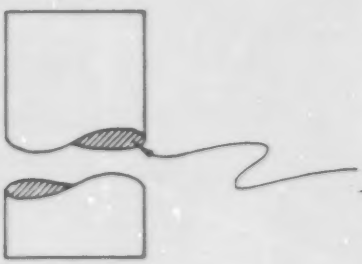

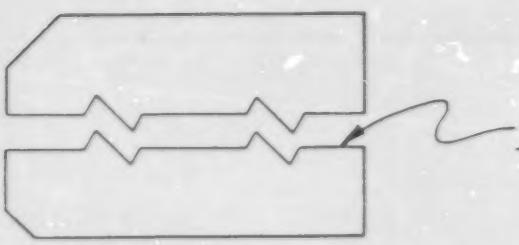

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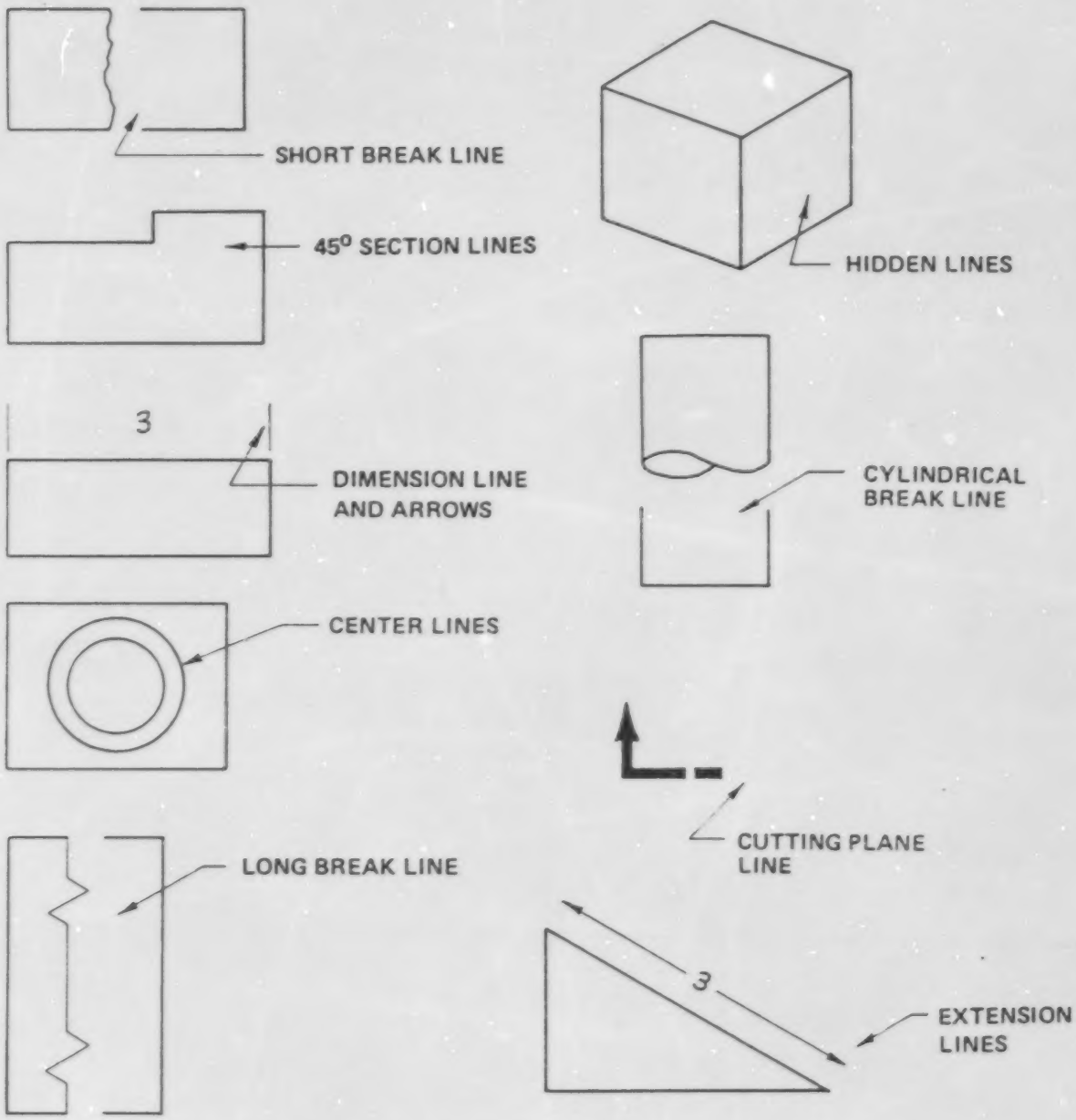

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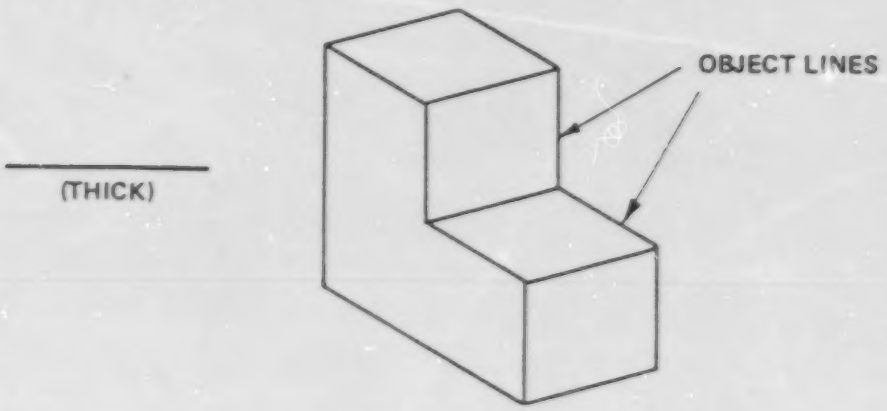

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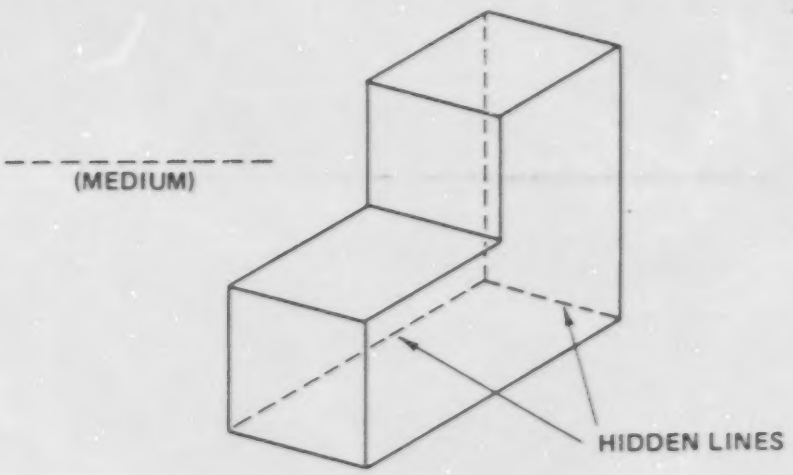

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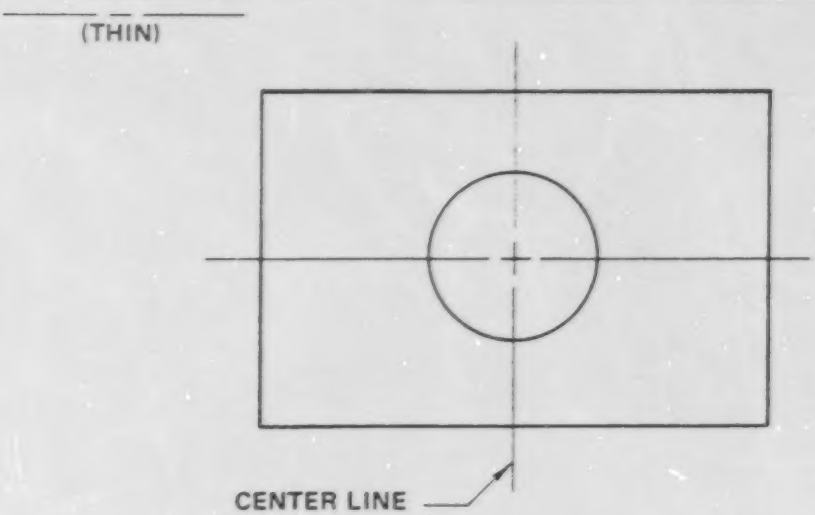

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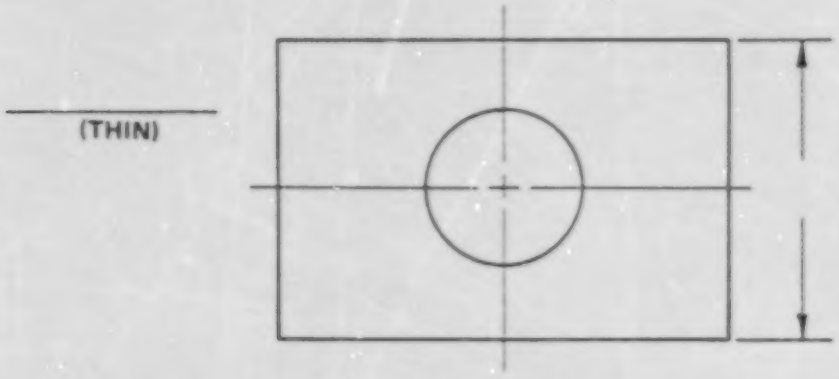

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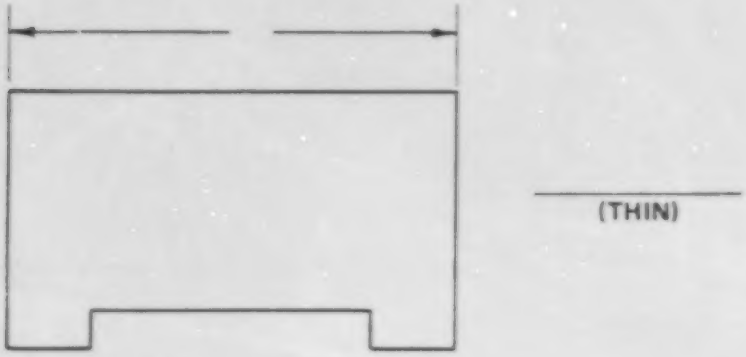

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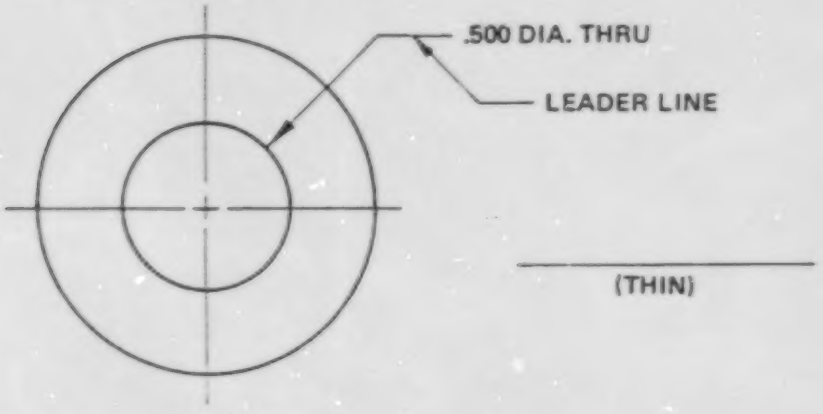

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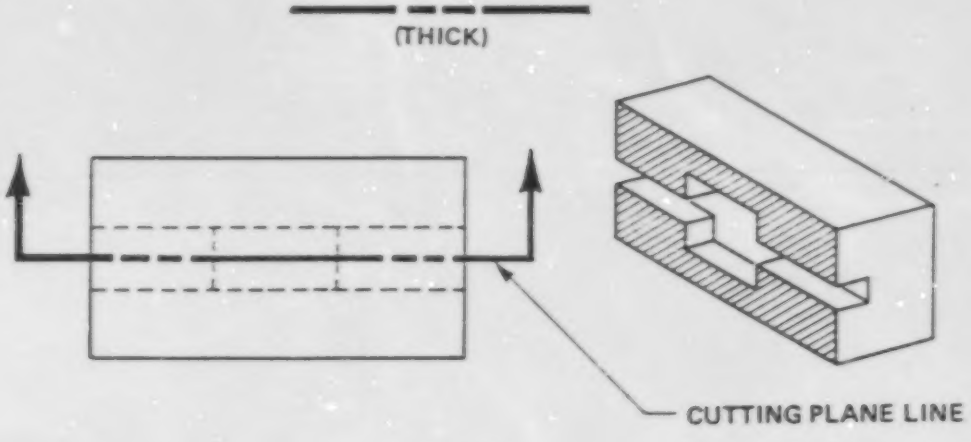

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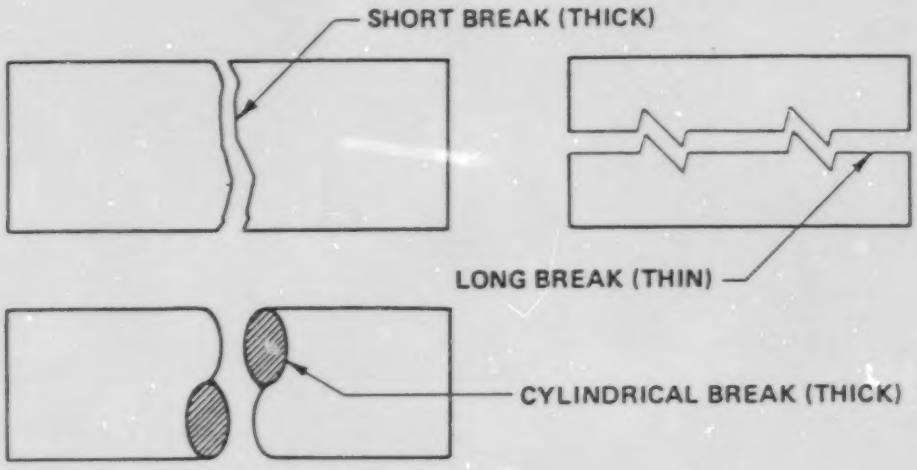

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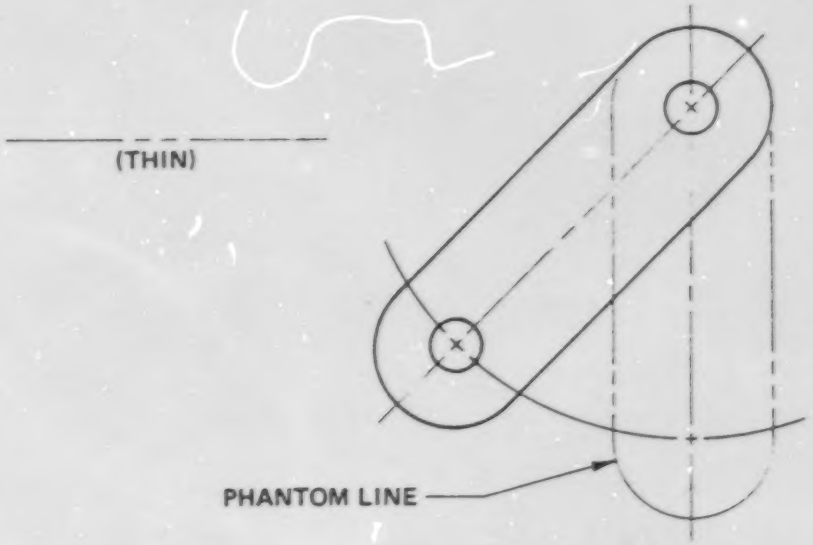

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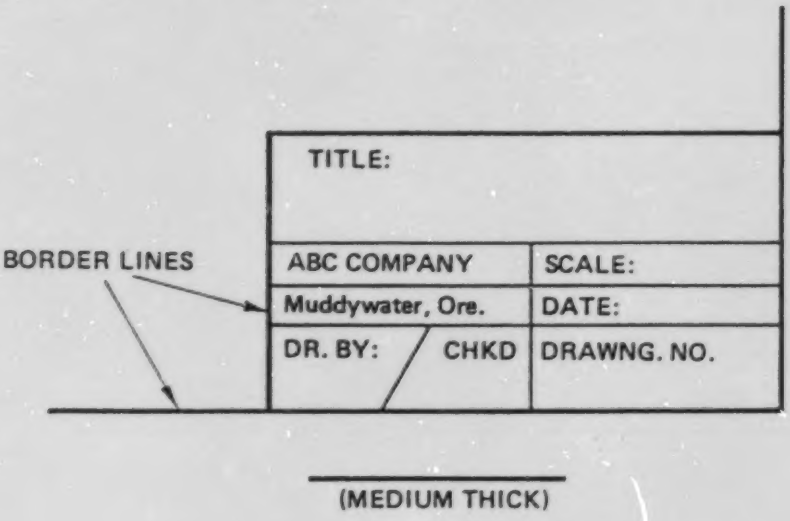

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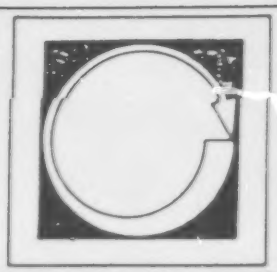

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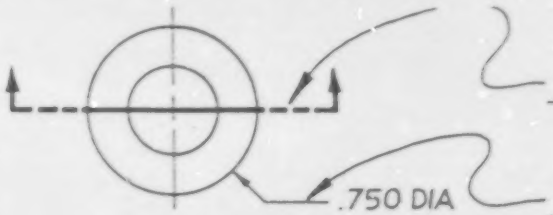
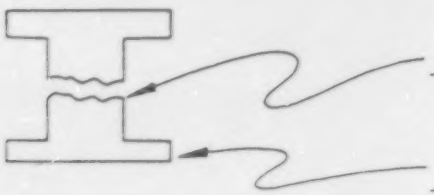
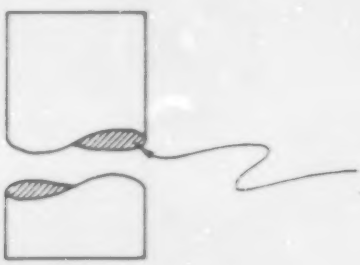
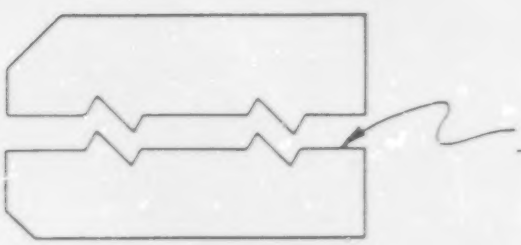




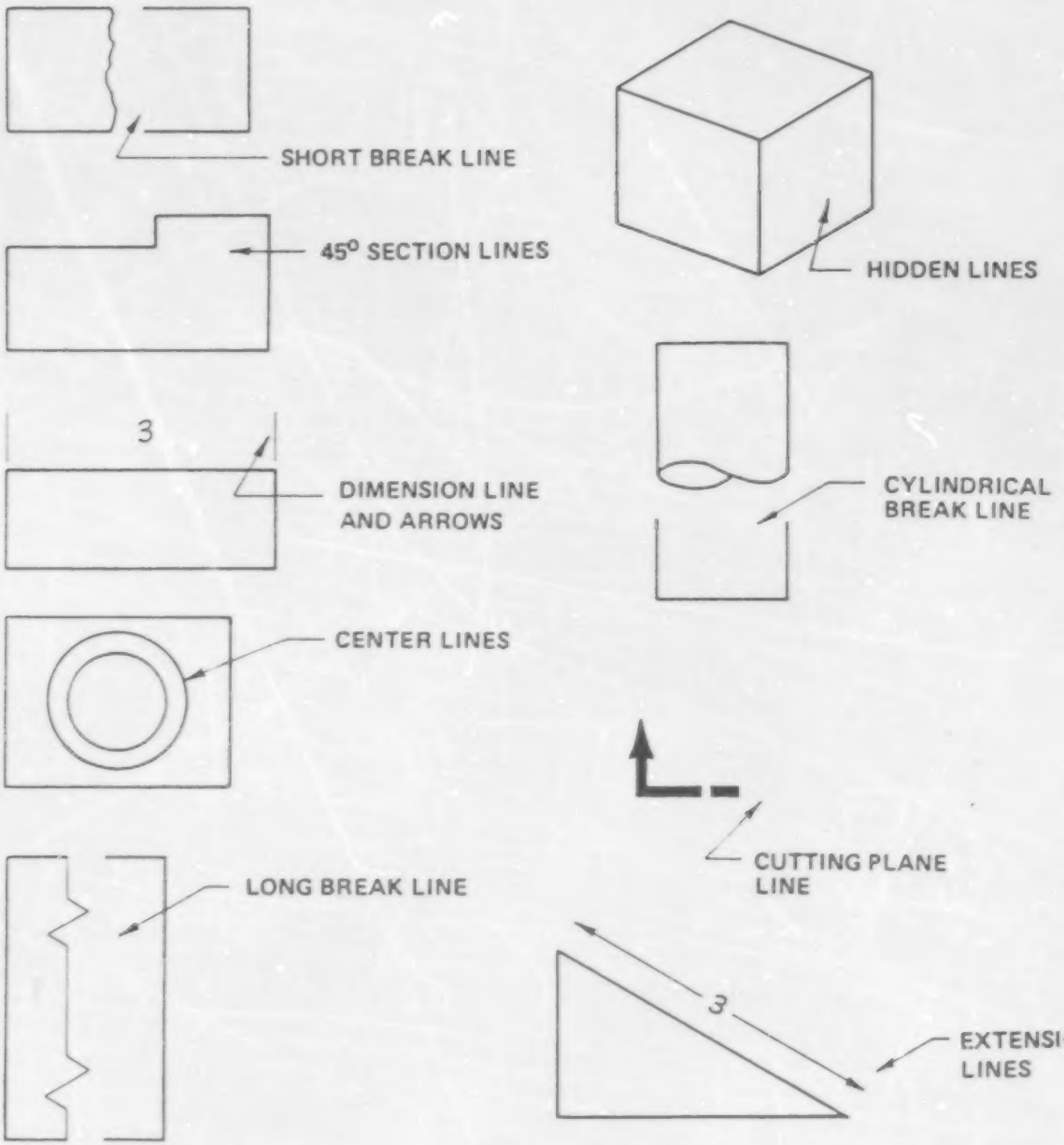




Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
4. Object line; 5. Extension line; 6. Cylindrical break;
7. Long break.

LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.



5.13

BLUEPRINT READING

Drafting: Basic Print Reading

Goal:

The apprentice will be able to read and interpret blueprints.

Performance Indicators:

1. Identify basic symbols and representations used in blueprints.
2. Relate two dimensional drawings to three dimensional objects.
3. Utilize measurements and scales to interpret blueprints.
4. Identify the purpose and configuration of commonly used machine features.
5. Interpret notes on blueprints for dimensions and tolerances.

Introduction

You have heard the saying that "a picture is worth a thousand words." This statement is particularly true in regard to technical drawings.

It would be nearly impossible for an engineer, designer, or architect to describe in words the shape, size and relationship of a complex object. Therefore, drawings have become the universal language used by engineers, designers, technicians, and craftspeople to communicate the information necessary to build, assemble and service the products of industry.

It is important to remember, as you study blueprint reading, that you are learning to communicate with the graphic language. Lines are part of the language.

Since technical drawings are made of lines, it is logical that the first step in learning to "read" a drawing is to learn the meaning of each kind of line. Generally, there are 11 basic types of lines. Each kind of line has a definite form and "weight." Weight refers to line thickness or width. When combined in a drawing, lines provide part of the information needed to understand the print.

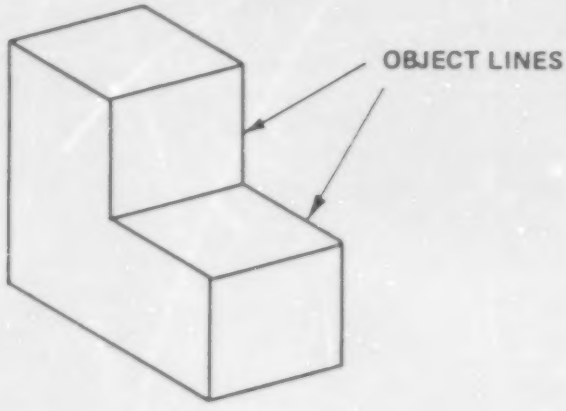
Information

The 11 lines used on prints are:

1. OBJECT LINE

An object line is a thick continuous line that indicates all the edges and visible surfaces of an object. An object line can also be called a visible line.

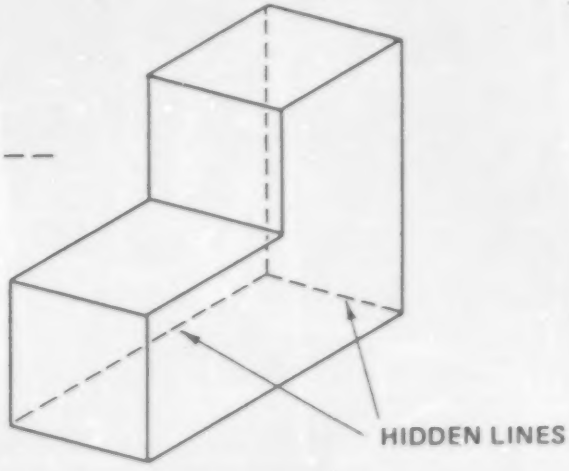
(THICK)



2. HIDDEN LINE

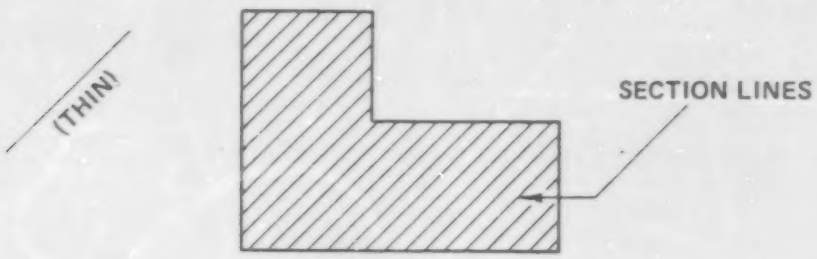
A hidden line is a medium weight line, made of short dashes, to show edges, surfaces and corners which cannot be seen. They are used to make a drawing easier to understand.

(MEDIUM)



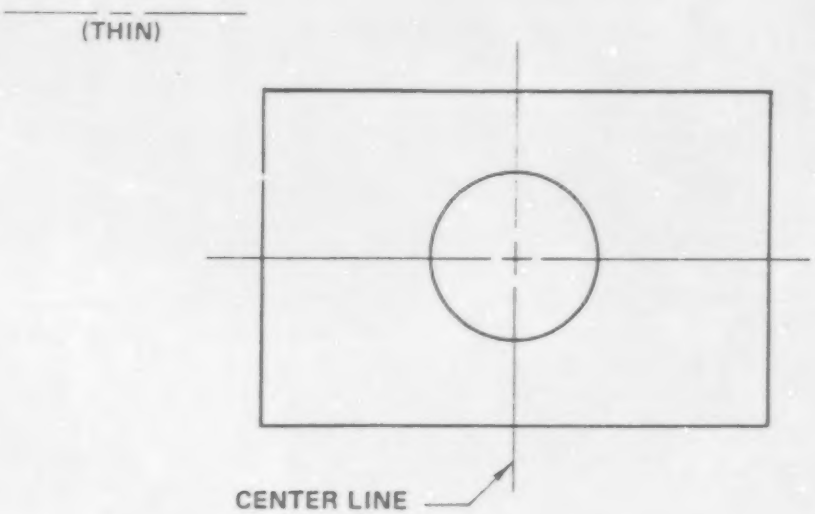
3. SECTION LINE

Section lines are used on a drawing to show how it would look if it were sectioned, or cut apart, to give a better picture of shape or internal construction. Section lines are very thin, and are usually drawn at 45 degrees. They show the cut surface of an object in sectional view. More on sections will be explained later.



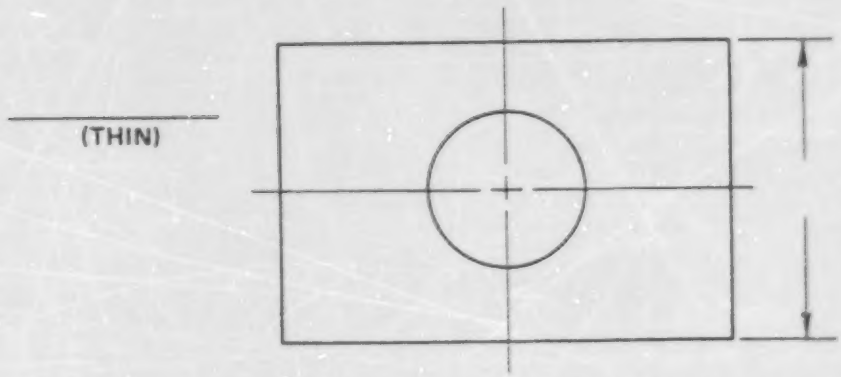
4. CENTER LINE

Center lines are used to indicate the center of holes, arcs, and symmetrical objects. They are very thin and consist of long-short-long dashes.



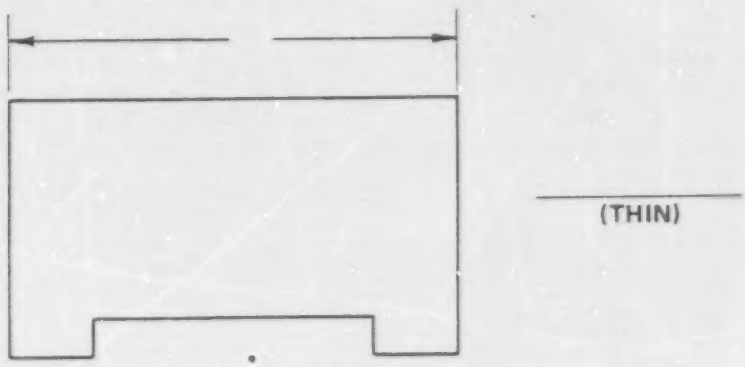
5. DIMENSION LINE

Dimension lines are thin lines used to show the extent and direction of dimensions on an object. Dimension lines usually end with an arrowhead.



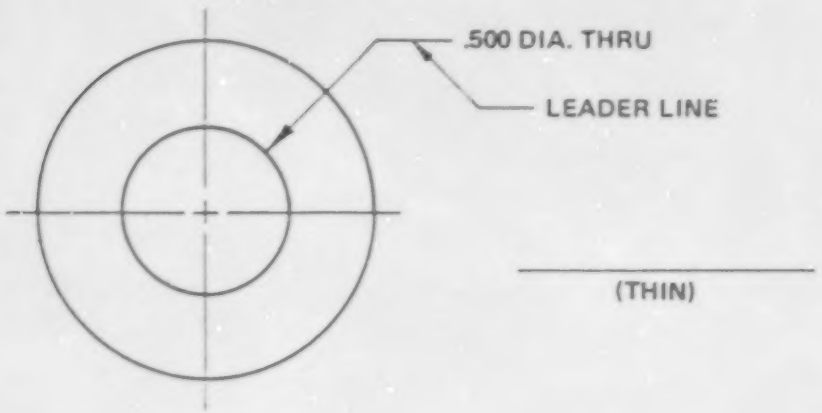
6. EXTENSION LINE

Extension lines are also thin lines showing the limits of dimensions. Dimension line arrowheads touch extension lines.



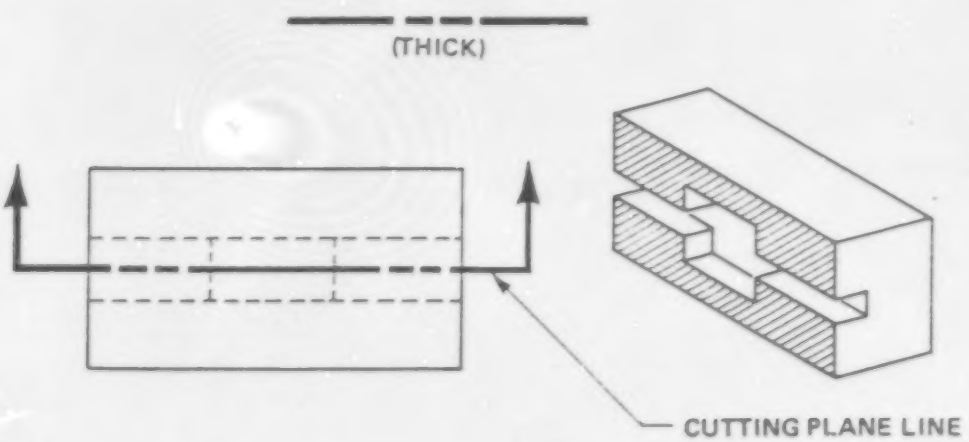
7. LEADER LINES

Leaders are more thin lines used to point to an area on a drawing requiring a note for futher explanation.



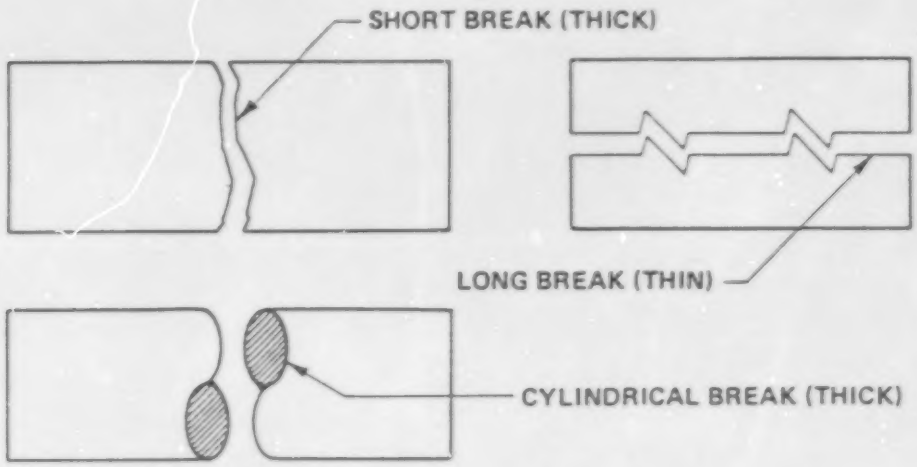
8. CUTTING PLANE LINE

A cutting place line (very heavy) helps to show a reference for sectioning. It is a line showing the plane where an imaginary cut is made to expose the internal shape of an object.



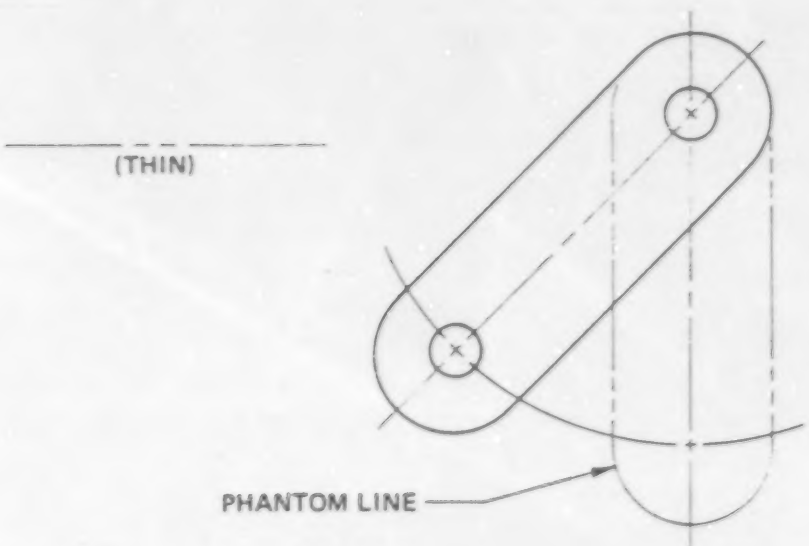
9. BREAK LINES (short, long, cylindrical)

There are three kinds of break lines used in drawings. They are used to remove or "break out" part of a drawing for clarity, and also to shorten objects which have the same shade throughout their length and may be too long to place on the drawing.



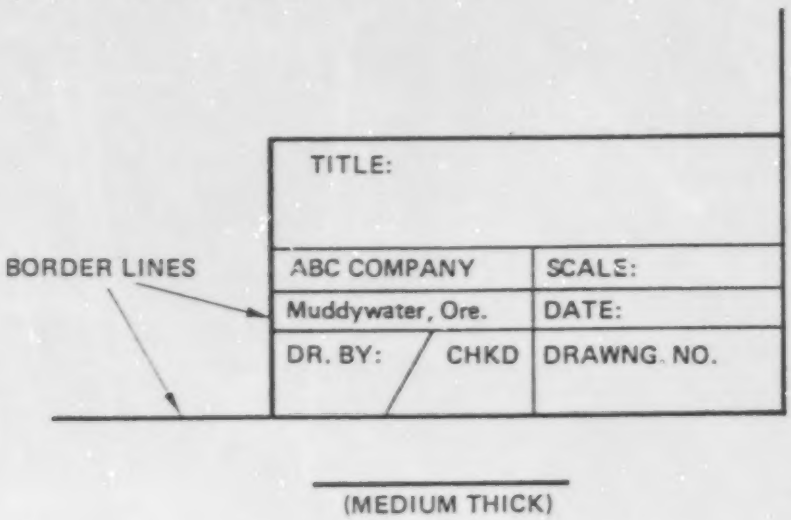
10. PHANTOM LINES

Phantom lines are thin, long-short-short-long lines most often used to show movement or travel of an object or part in alternate positions. It can also be used to show adjacent objects or features.



11. BORDER LINES

Border lines are medium thick, continuous lines used to show the boundary of the drawing or to separate different objects drawn on one sheet. They are also used to separate the title block from the rest of the drawing.

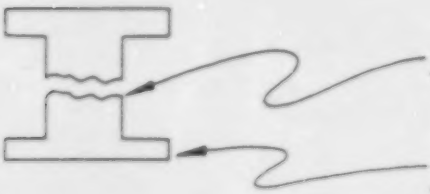


Self Assessment

Directions: Name the types of lines shown below. Check your own answers.

_____

_____



_____

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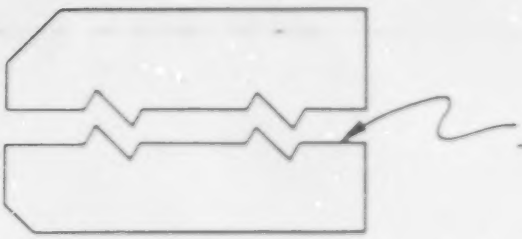
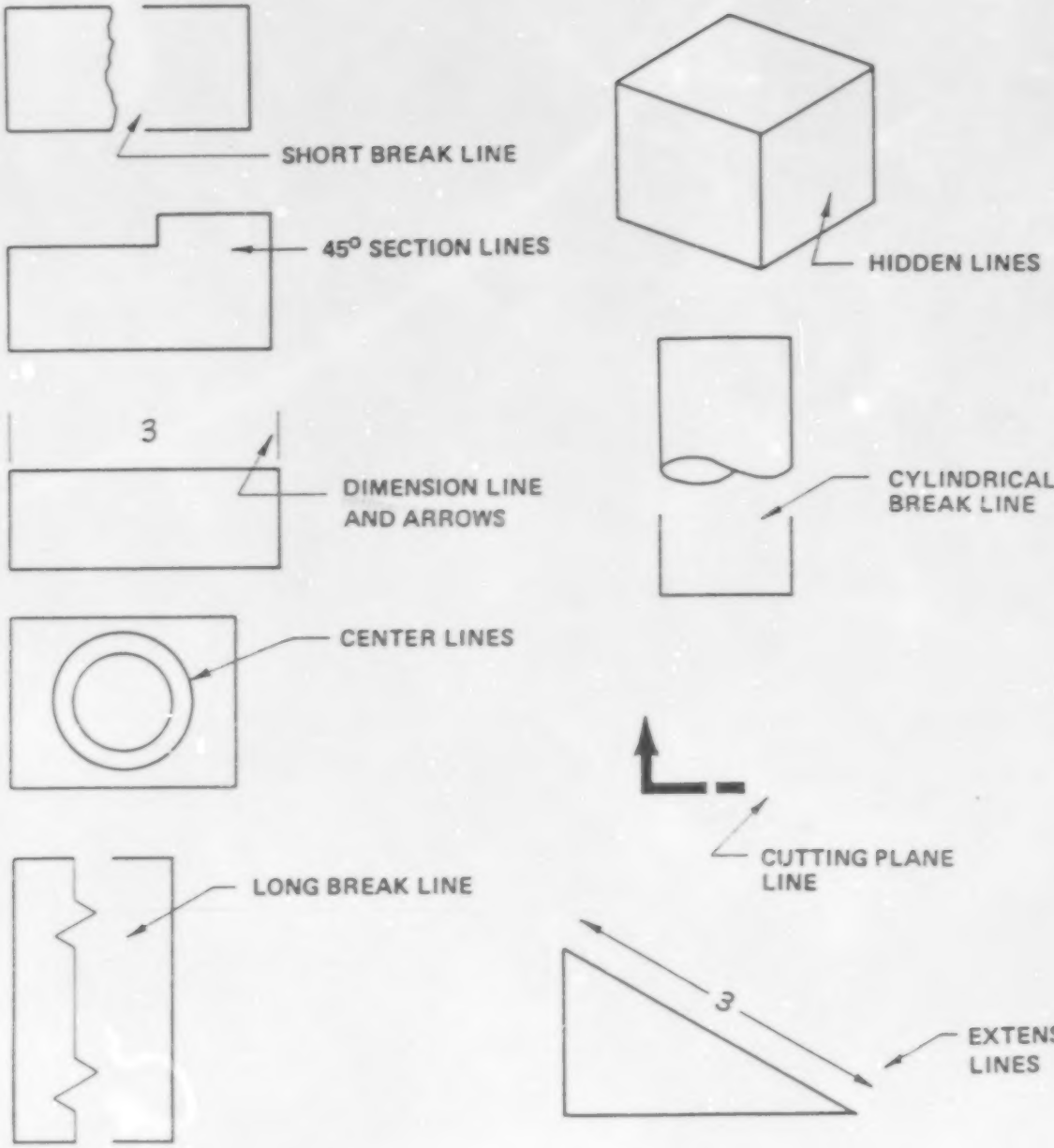


_____

Answers: 1. Cutting plane line; 2. Leader line; 3. Short break
4. Object line; 5. Extension line; 6. Cylindrical break;
7. Long break.

LINE LANGUAGE REVIEW

Directions: Draw the kinds of lines needed to complete the figures below.



5.14

DRAFTING

MACHINED FEATURES

Bevel
Boss
Chamfer
Counterbore
Countersink
Dovetail
Fillet
Kerf
Keyway
Keyseat
Knurl
Lug
Neck
Pad
Round
Spline
Spot Face
T-Slot

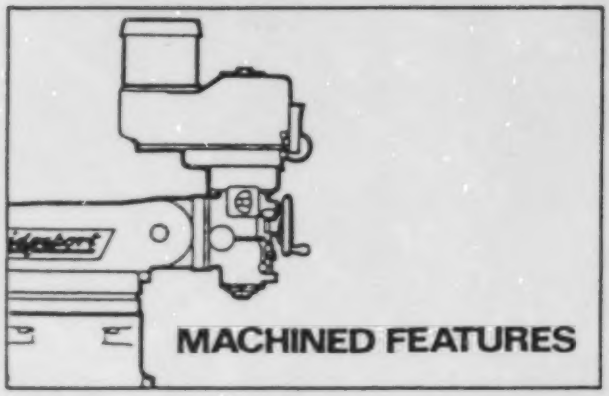
Goal:

The student will be able to identify the purpose and configuration of several commonly used machine features.

Performance Indicators:

Given a prepared worksheet, the student will identify various machined surfaces by name.

Introduction



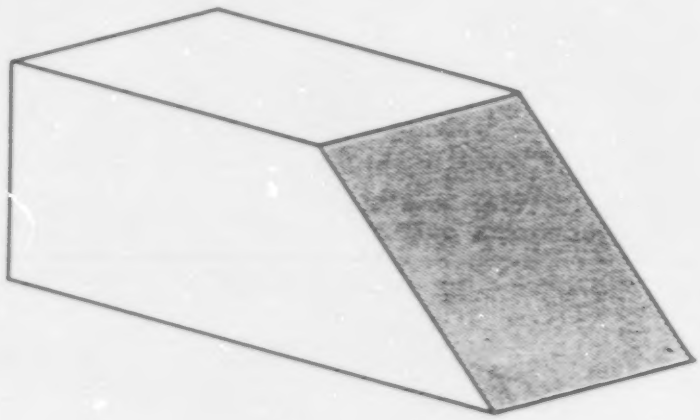
INTRODUCTION:

The machined features in this package are common terms related to basic industry processes. These terms are often found on prints; therefore, it is important to understand their use and purpose. This module will explain a little about each of these machined features.

Information

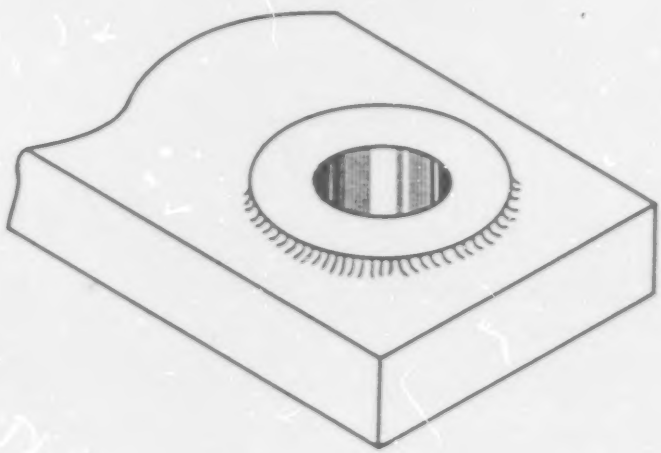
1. BEVEL

A surface cut at an angle.



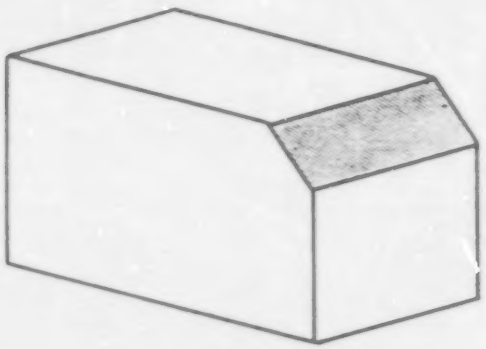
2. BOSS

A circular pad on forgings or castings which projects out from the body of the part. The surface of the boss is machined smooth for a bolt head to sit on and it has a hole drilled through to accommodate the bolt shank.



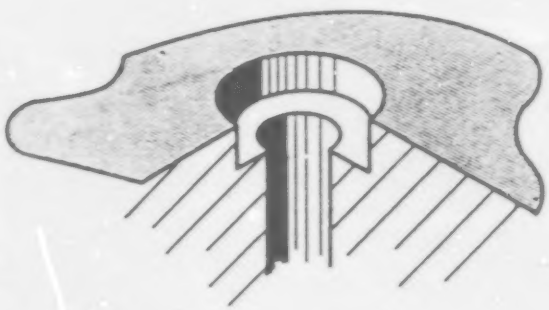
3. CHAMFER

The process of cutting away a sharp external corner or edge.



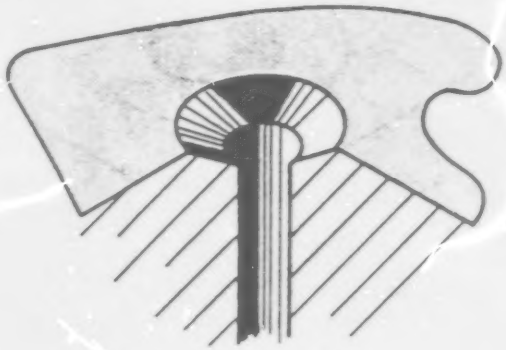
4. COUNTER BORE

To enlarge a drilled hole to a given diameter and depth. Usually done for recessing a bolt head.



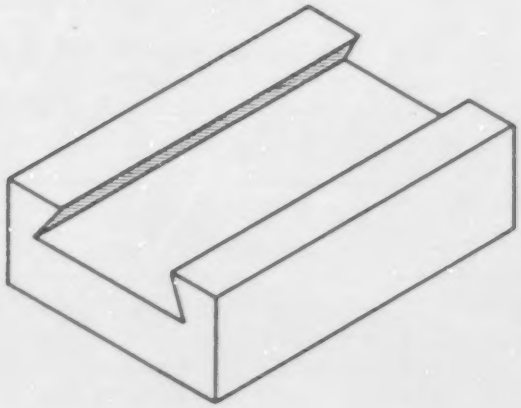
5. COUNTER SINK

To machine a conical depression in a drilled hole for recessing flathead screws or bolts.



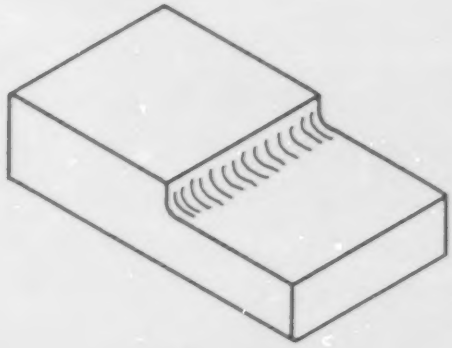
6. DOVETAIL

A slot of any depth and width which has angled sides. Used to allow another part to slide without separating from the dove-tailed part.



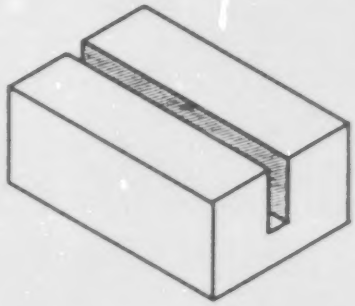
7. FILLET

A small radius filling formed between the inside angle of two surfaces.



8. KERF

The narrow slot formed by removing material while sawing or other machining.

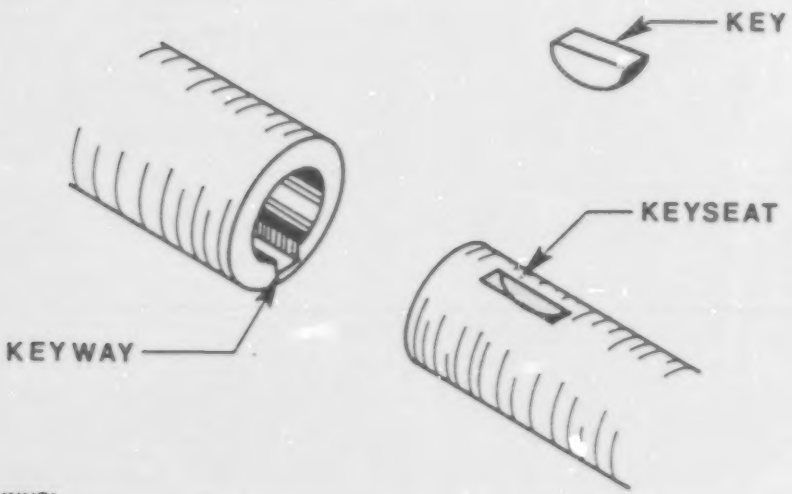


9. KEYWAY

A narrow groove or slot cut in the shaft hole of a sleeve, hub, or gear to accommodate a key.

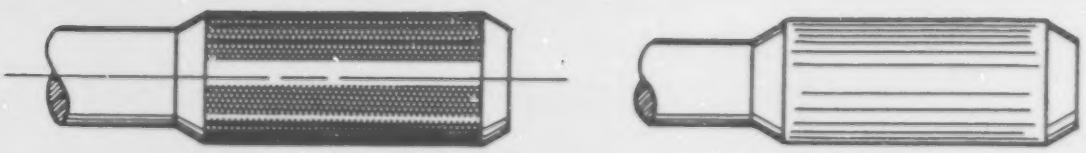
10. KEYSEAT

A narrow groove or slot cut in a shaft to accommodate a key.



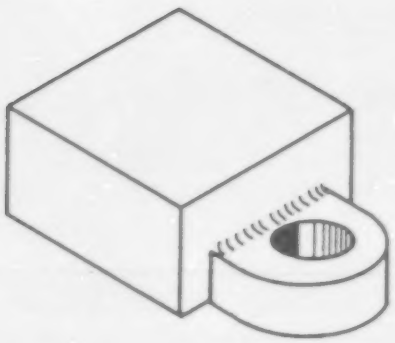
11. KNURL

To uniformly roughen, with a diamond or straight pattern, a cylindrical or flat surface.



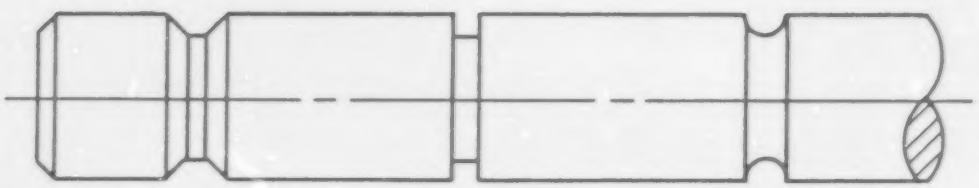
12. LUG

A piece projecting out from the body of a part, usually rectangular in cross-section with a hole or slot in it, used for mounting or securing.



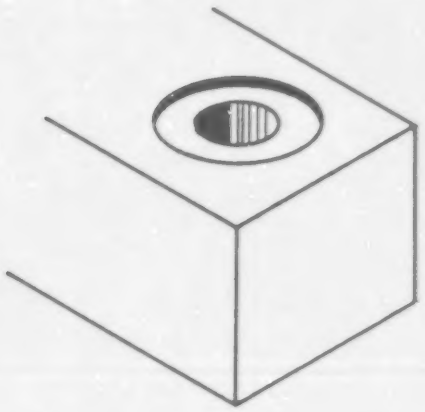
13. NECK

A narrow machined groove on the cylindrical part of an object, used to hold a retaining ring.



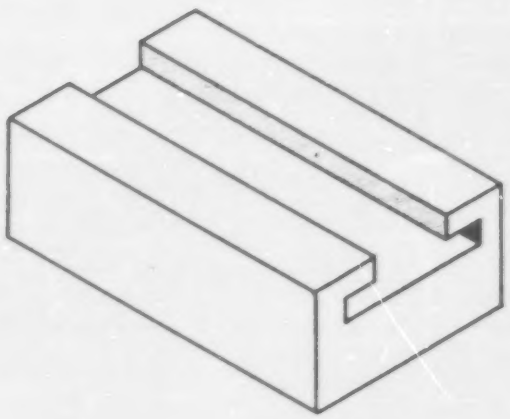
14. SPOT FACE

A round surface on a casting or forging for a bolt head. Usually less than 1/16 of an inch deep.



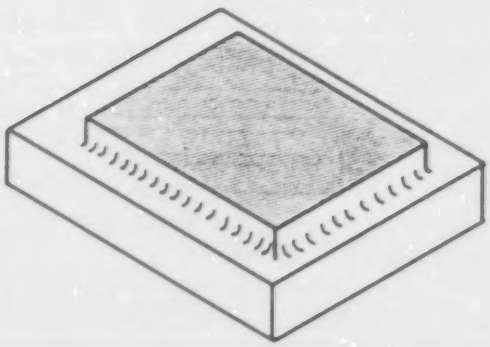
15. T-SLOT

A slot of any dimensions cut to resemble a "T." Used much like a dovetail for locking pieces into position.



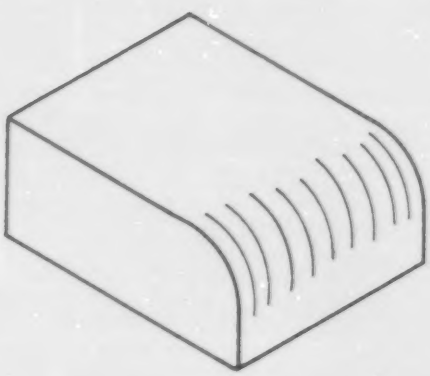
16. PAD

A slightly raised surface projecting out from the body of a part for bearing or surface wear. The pad surface can be any size or shape. (Remember, bosses are round and have a hole through them.)



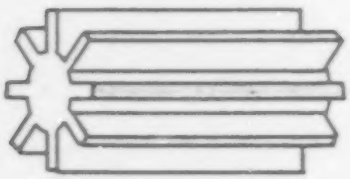
17. ROUND

A small radius, rounded, outside corner formed between two surfaces, to eliminate rough, sharp corners and reduce material usage.



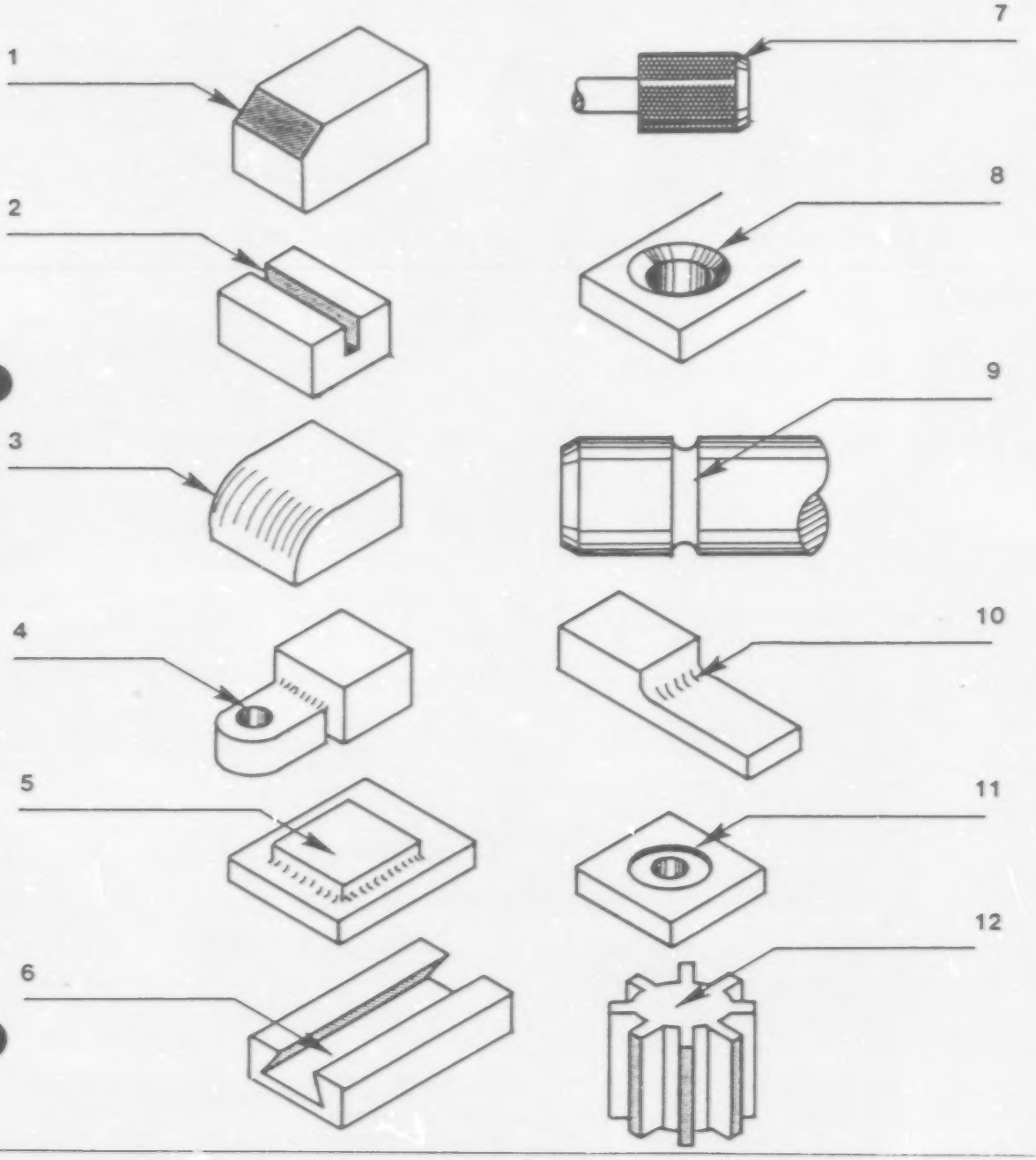
18. SPLINE

A gear-like serrated surface on a shaft, which takes the place of a key in special power transmission problems.



• Self Assessment

Directions: Write your answers in pencil in spaces provided.
Check your test with the answers on the next page.



Answers to self test:

1. Chamfer
2. Kerf
3. Round
4. Lug
5. Pad
6. Dovetail
7. Knurl
8. Counter sink
9. Neck
10. Fillet
11. Counter Bore
12. Spline

5.15

DRAFTING

MEASUREMENT

Scale Measurement
Full Size
Half Size
Quarter Size

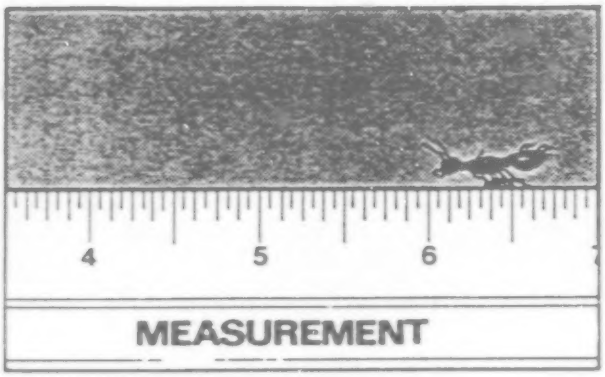
Goal:

The student will be able to use measurements and scales in working with blue prints for industry.

Performance Indicators:

Given prepared worksheets, the student will locate various fractional dimensions or typical drafting scales.

Introduction



INTRODUCTION:

The ability to make accurate measurements is a basic skill needed by everyone who reads and uses blueprints. Since some students have had little need to measure accurately, these exercises will provide the practice they need. Others who have had more experience may find these exercises a worthwhile review.

Remember, if you need a dimension from a print that is unclear or not given, DON'T MEASURE THE PRINT! Since prints shrink, stretch, and may not be drawn to scale, you can easily come up with some very inaccurate dimensions.

Information

1. SCALE MEASUREMENT

A drawing of an object may be the same size as the object (full-size), or it may be larger or smaller than the object. In most cases, if it is not drawn full-size, the drawing is made smaller than the object. This is done primarily for the convenience of the users of the drawings. After all, who wants to carry around a full-size drawing of a locomotive? Obviously, with an object as small as a wristwatch, it would necessary to draw at a larger scale.

A machine part, for example, may be half size (1/2" = 1"); a building may be drawn 1/48th size (1/4" = 1'-0"); a map may be drawn 1/1200th size (1 1/2 = 100'-0"); and a gear in that wristwatch may be drawn ten times the size (10" = 1").

There are numerous scales for different needs. Since each occupational group has its own frequently used scales, some practice or basic review will help you to work with the scales used in your technology.

2. FULL-SIZE

Full-size is simply letting one inch (or unit) on a ruler, steel rule, or draftsperson's scale equal one inch (or unit) on the actual object. Rules of this kind are usually divided into sixteen units per inch or 32 units per inch.

Here is a "big inch." Each space equals 1/32 of an inch.

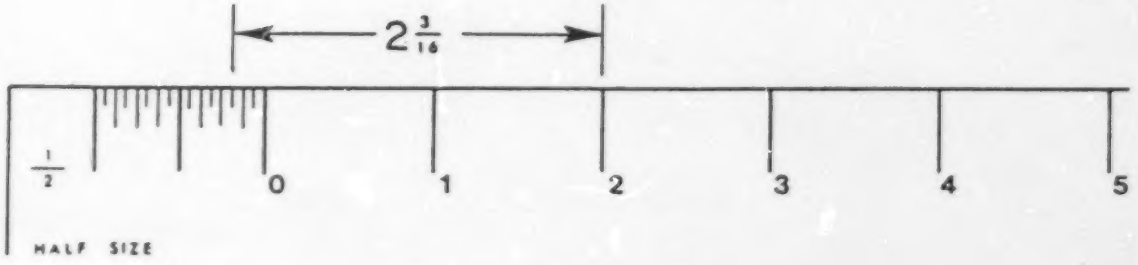
On the scale above, locate the following fractions.

1. 5/8
2. 3/16
3. 7/32
4. 15/16
5. 25/32
6. 7/8
7. 11/16
8. 5/16
9. 31/32
10. 19/32

3. HALF SIZE

The principle of half size measurements on a drawing is simply letting one unit, such as 1/2 inch on the scale, represent a larger unit such as 1 inch on the drawing. If the drawing is properly labeled, the words "half size" or 1/2" = 1" will appear in the title block.

Using the half size scale isn't difficult, but it does take some practice. To measure a distance of 2 3/16 in half size you look first for the whole unit 2 then go backwards to the zero and count off the additional 3/16. You measure this way for each dimension that has a fraction. Whole numbers (numbers without fractions) are measured in the usual way.



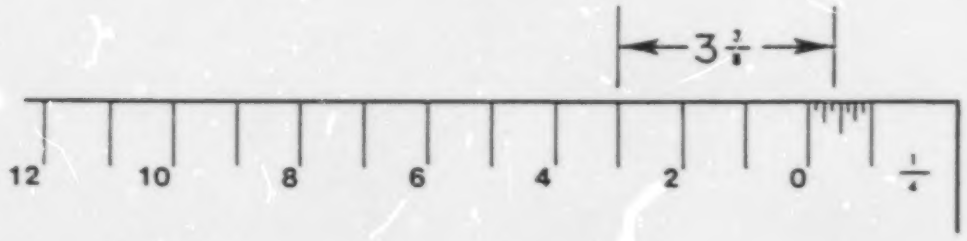
With the scale above, practice locating the following half size dimensions.

1. 4 3/16
2. 2 1/2
3. 5 3/4
4. 13/16
5. 3 3/8
6. 4 13/32

4. QUARTER SIZE

Quarter size is used and read in a similar way to half size, except that each unit, such as a quarter of an inch, represents a larger unit, such as one inch. If the drawing is properly labeled the words "quarter size" or "quarter scale" or 1/4" = 1" will appear in the title block.

The example below shows a dimension of 3 3/8 inches.



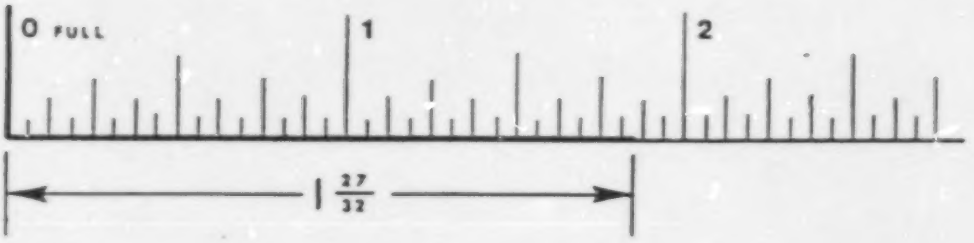
Using the scale above, practice locating the following dimensions.

1. 2 5/8
2. 3 7/8
3. 6 1/4
4. 8 1/8
5. 5 3/8
6. 10 3/4
7. 4 5/8
8. 11 1/4

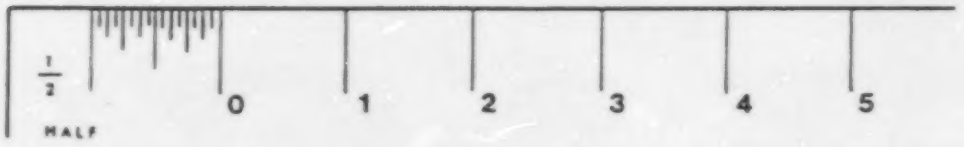
Self Assessment

Directions: Place the dimensions given above each scale to show that length. Check your answers. If you have 5 or more right, go on to the next section. If not, repeat this module. The first problem is done for you as an example.

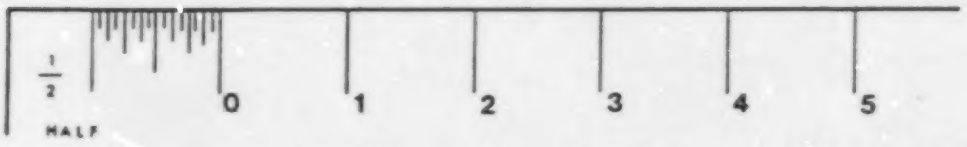
1. $1\frac{27}{32}$



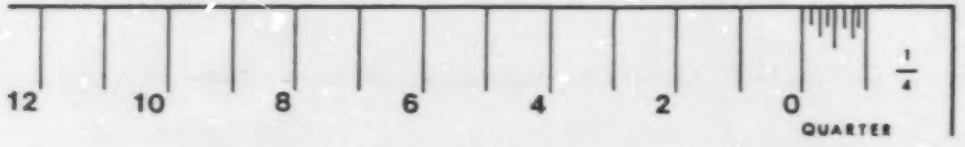
2. $4\frac{7}{16}$



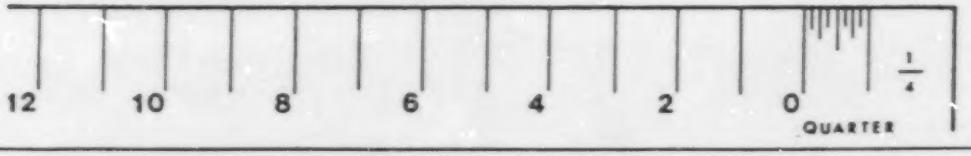
3. $3\frac{19}{32}$



4. $11\frac{5}{8}$

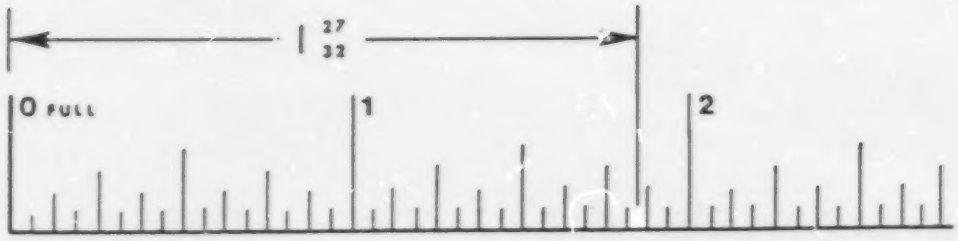


5. $2\frac{3}{16}$

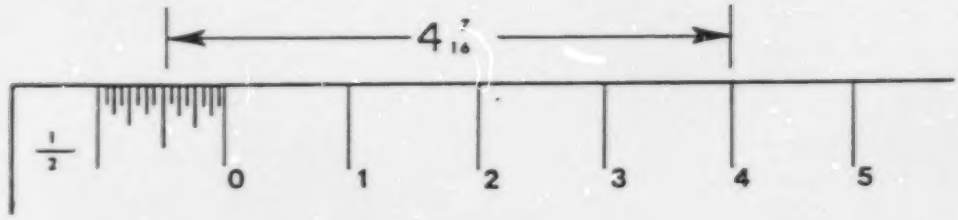


Answers to self test:

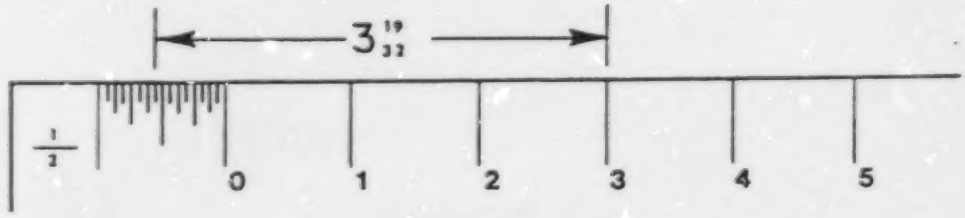
1.



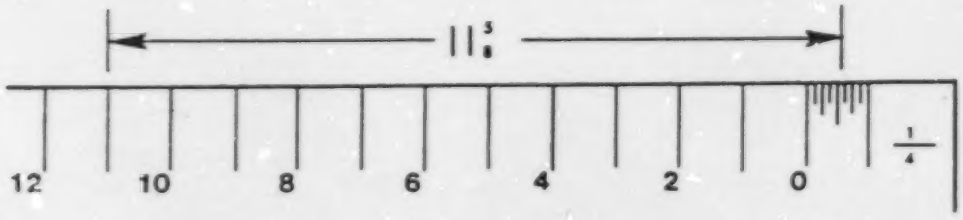
2.



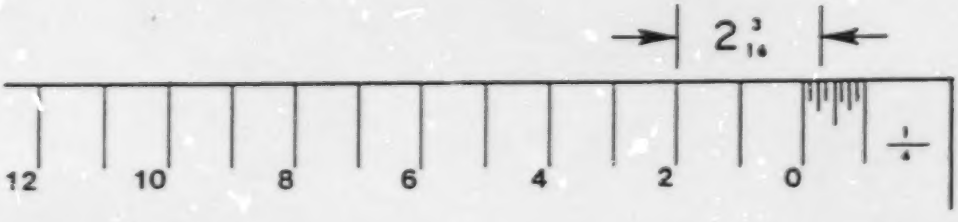
3.



4.

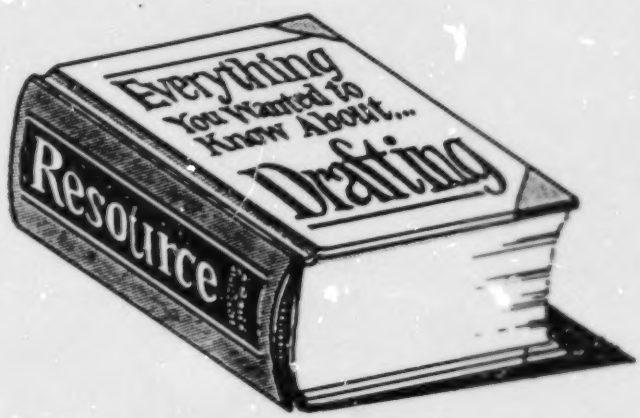


5.



Study Guide

For Further Information:



Drafting and Graphics, Giachino and Beukema, 2nd Edition, pp. 4-7.

Technical Drawing, Giesecke, et al, 6th Edition, pp. 30-35.

Drafting for Industry, Brown, 1974, pp. 31-33.

ILS Drafting: Measuring Instruments, article 7.00

5.16

DRAFTING

VISUALIZATION

Perspective
Oblique Drawing
Isometric Drawing
One-View Drawing
Two-View Drawing
Orthographic Projection
Hidden Surfaces
Curved Surfaces
Inclined Surfaces

Goal:

The student will learn to be able to relate two-dimensional representations of three-dimensional objects.

Performance Indicators:

On a prepared worksheet, the student will fill in lines needed to complete a third view.

Introduction

INTRODUCTION:

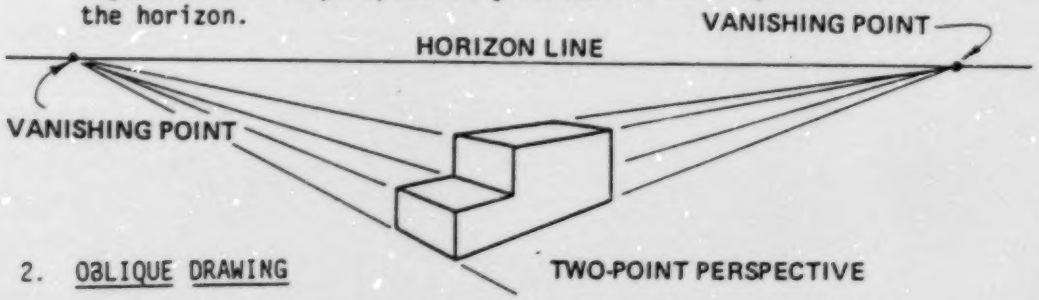
The ability to "see" technical drawings; that is, to "think in three dimensions" is the most important part of this course. Since most engineering and architectural prints utilize some form of orthographic projection (multi-view drawing), that type of drawing will be emphasized.

Before going into a study of orthographic projection, you should be able to recognize several other types of drawings. They are: (1) perspective drawing, (2) oblique drawing, and (3) isometric drawing. As a group, they are called pictorial drawings. They are found on prints and they are easy to visualize, so let's look at their differences.

Information

1. PERSPECTIVE

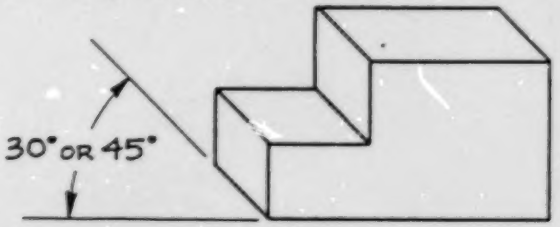
Perspective is the most realistic form of drawing. Artists use one-point perspective, two-point (shown here), and three-point to create visual depth. Perspectives are used by architects and for industrial pictorials of plant layouts, machinery, and other subjects where realism is required. Objects drawn in perspective grow smaller as they recede into the horizon.



TWO-POINT PERSPECTIVE

2. OBLIQUE DRAWING

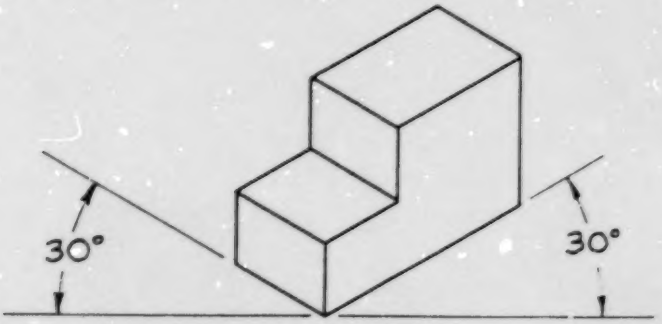
Oblique drawings are made with one plane (front) of the object parallel to the drawing surface. The side, or other visible part of the object is generally drawn at 30 or 45 degrees. Note that only the side is on an angle.



OBLIQUE DRAWING

3. ISOMETRIC DRAWING

Isometric drawings have less distortion than oblique drawings, and are used more frequently by industry for that reason. An isometric drawing has both visible surfaces drawn at 30 degrees.

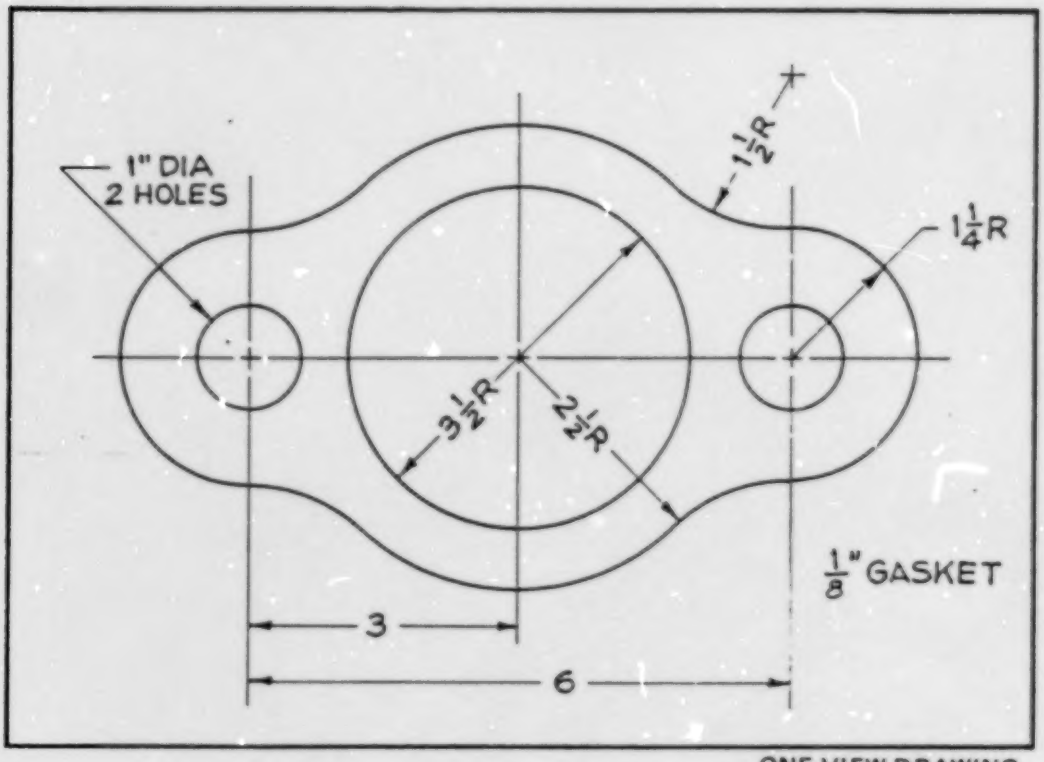


4. ONE-VIEW DRAWING

A single view of an object is sometimes all that is needed for a complete visual explanation. When dimensions, material, and other information is included, and object requiring only a single view is usually easy to understand.

Most one-view drawings are of flat objects, made from materials such as sheet metal and gasket stock. Spherical objects, such as a cannonball, would require only one view and a note indicating the material and diameter of the sphere.

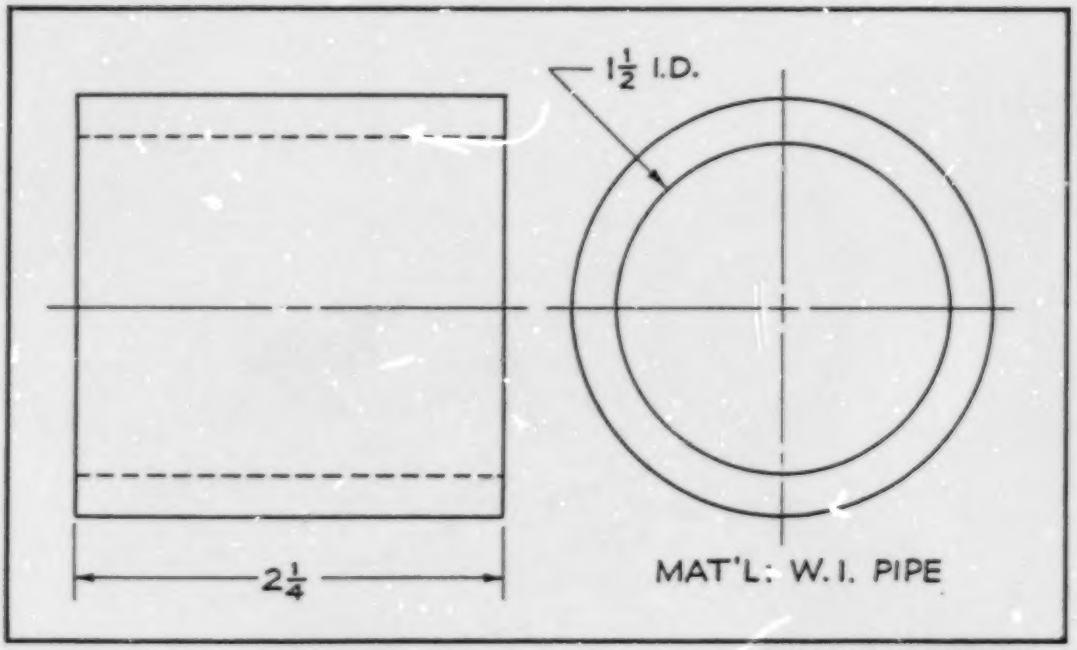
The object shown below could be made of any appropriate material that might be specified. In appearance, it is much like the gasket used in part of the cooling system of many cars.



ONE-VIEW DRAWING

5. TWO-VIEW DRAWING

Two-view drawings are sometimes found on prints since two views may be all that is needed to show the shape of an object. Objects which are cylindrical, such as the length of pipe, are usually shown on a print with two views. In such a case, two views are sufficient to explain the shape. Notice in the two-view drawing below that the length of pipe is shown in one view and the diameter is called out in the other. The hidden or dashed lines indicate the inside surface of the pipe which cannot be seen.

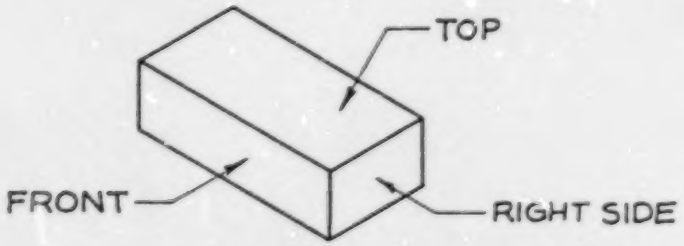


TWO-VIEW DRAWING

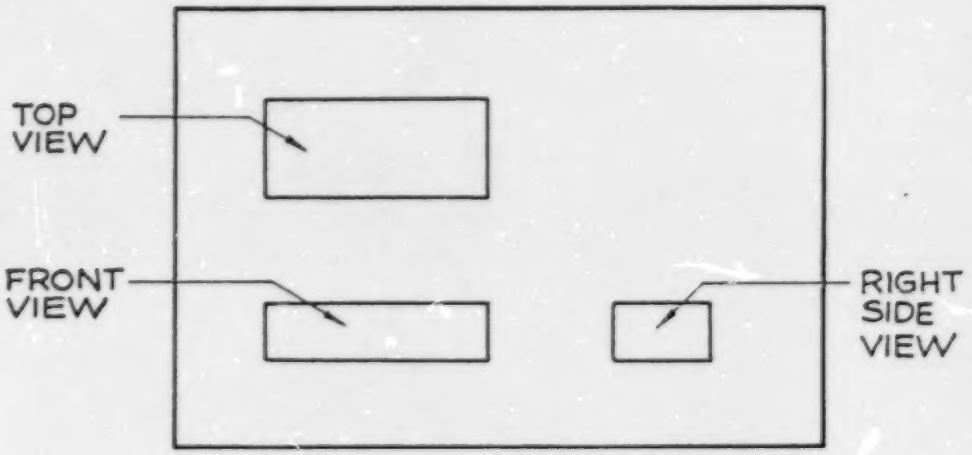
6. ORTHOGRAPHIC PROJECTION

Orthographic projection is a name given to drawings which usually have three views. Often, the three views selected are the top, front and right side. It's possible, when necessary, to select other views such as the left side or the bottom. Generally, though, the top, front and right side views are traditionally seen by the person reading prints.

Since most prints make use of the orthographic projection system, and because the top, front and right side views are most often used, it's important that you know their order or arrangement on the print. To help you understand this system, think of a chalk board eraser, a short length of 2 x 4 lumber, or a common brick. It looks like this:

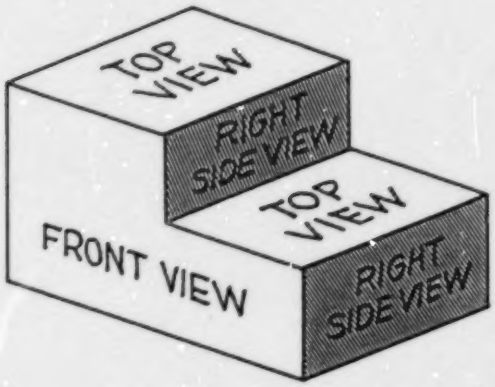


When seen on a print, using orthographic projection, it would look like this:

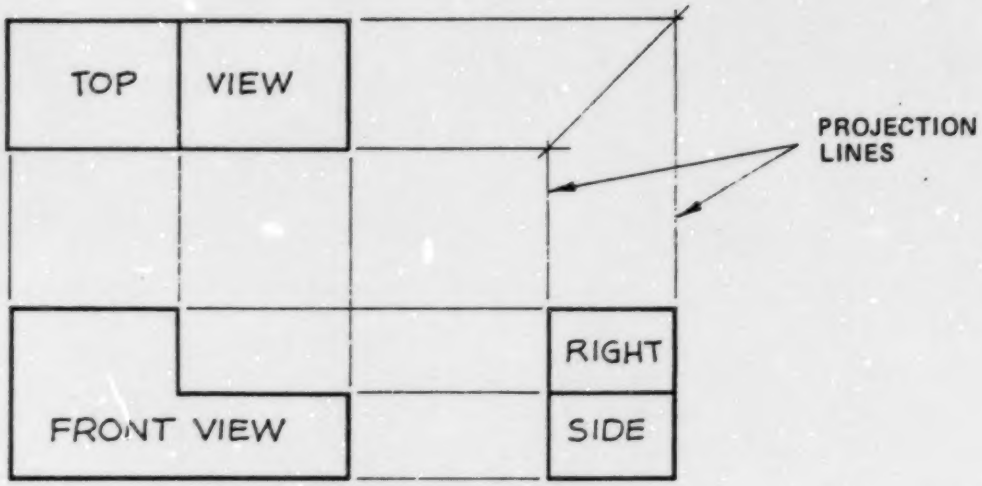


ORTHOGRAPHIC LAYOUT

This system of orthographic projection may be difficult to understand or visualize at first, but you will grasp it with some practice. Here's a basic example of how it works, using a simple object.

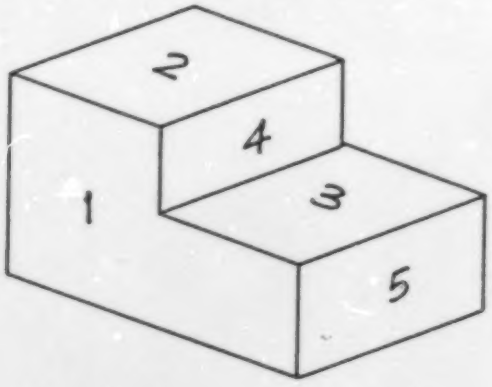


Orthographic projection does not show depth, so the object shown above will appear flat. With practice, however, you will learn to scan the three views and "read" depth into them. Remember that the location of the top, front and right side views does not change. The projection lines between the orthographic views below show the height, width and depth relationships that exist between each of the views.

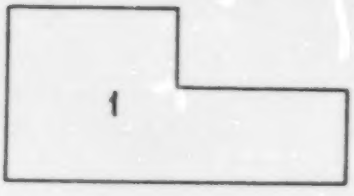


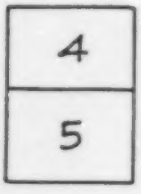
ORTHOGRAPHIC PROJECTION

In case you didn't understand the three-view on the last page, let's take another look at the same thing. This time numbers will be used for identification of the surfaces.



Using orthographic projection, the object with surfaces numbered appears like this:





Notice that the front view (1) is the key to the drawing because it most clearly shows the shape of the object. The other two views don't tell you much about the shape of the object by themselves. By looking at surface 1, however, you can see that 2 is taller than 3. Therefore, in "reading" the surfaces, 2 should appear to be closer to you than 3. Now look at 4 and 5. Which surface is projected closest to you?

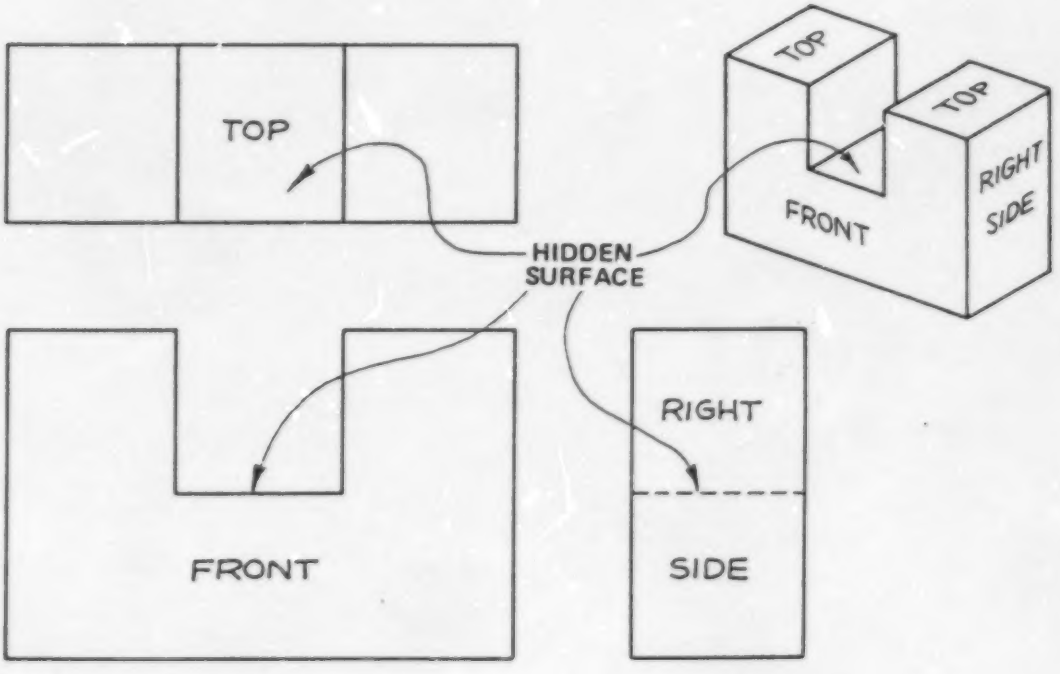
(Surface 5)

You may be wondering at this point why something like orthographic projection is used on prints when isometric or oblique drawings are so much easier to visualize. The answer is that isometric and oblique pictorials are used for relatively uncomplicated drawings. When an object is complex, neither pictorial can equal the orthographic system for a clear presentation of dimensions, notes, and configuration details.

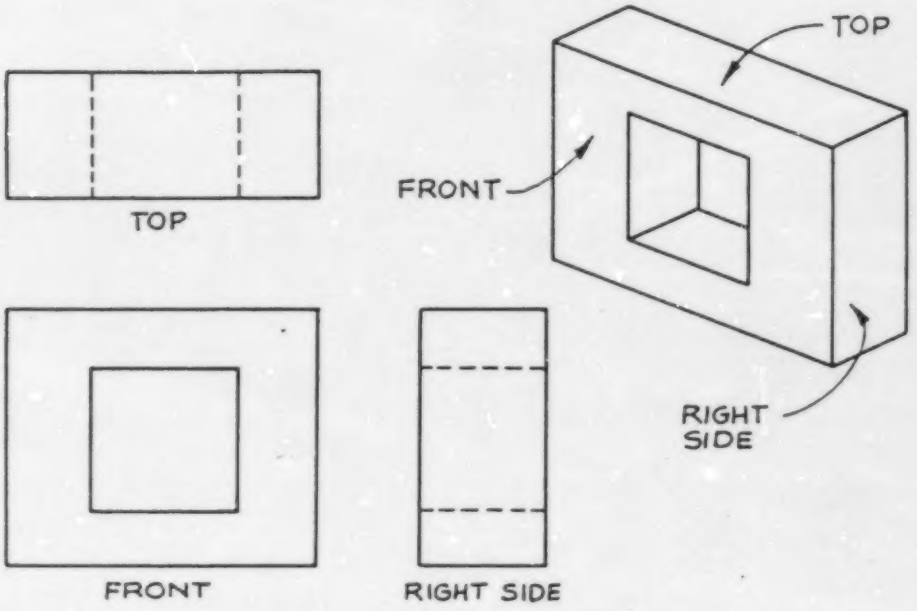
7. HIDDEN SURFACES

Another advantage of orthographic projection is that it allows the person reading the print to have the ability to see the inside, or surfaces of an object which normally could not be seen. With complicated objects in pictorial, this transparent viewing can become very useful in completely describing the object.

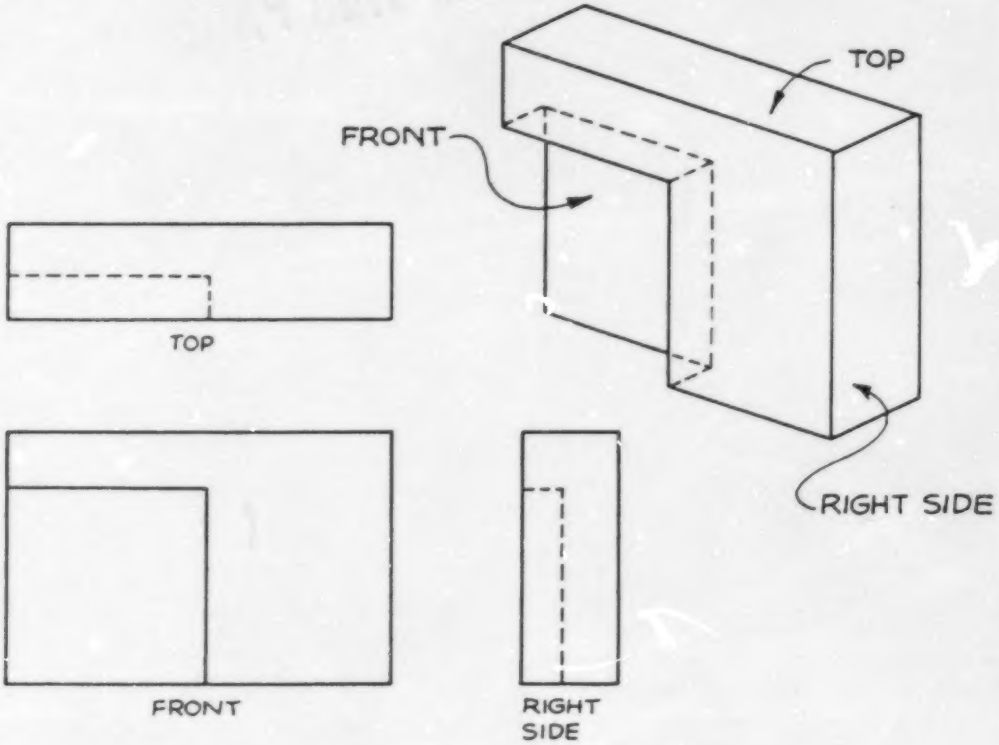
In the drawing below, the hidden line in the right side view represents the entire surface of the flat area between the two higher sides.



In this example, the hidden lines result from a square hole through the middle of the object.

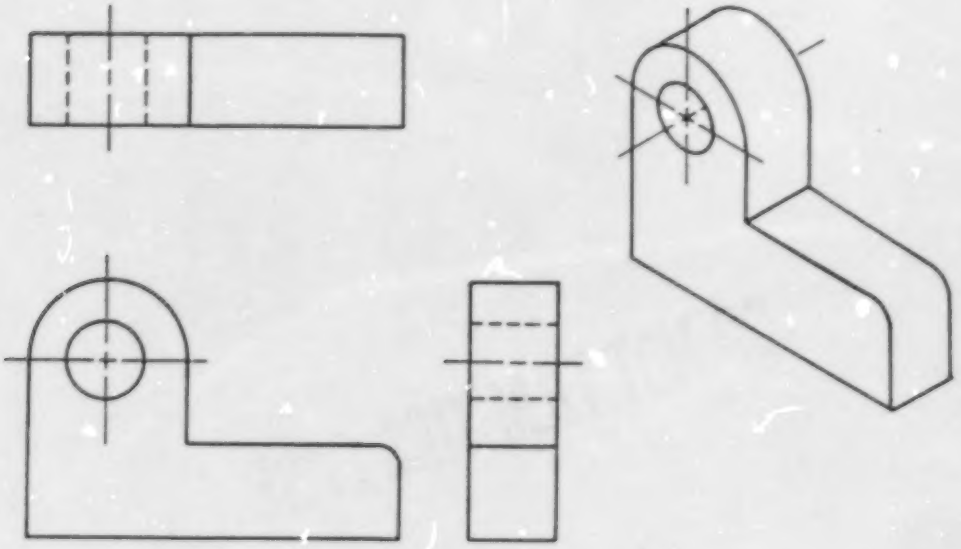


The hidden lines in this example are there because a part of one corner of the front surface has been cut away or recessed.

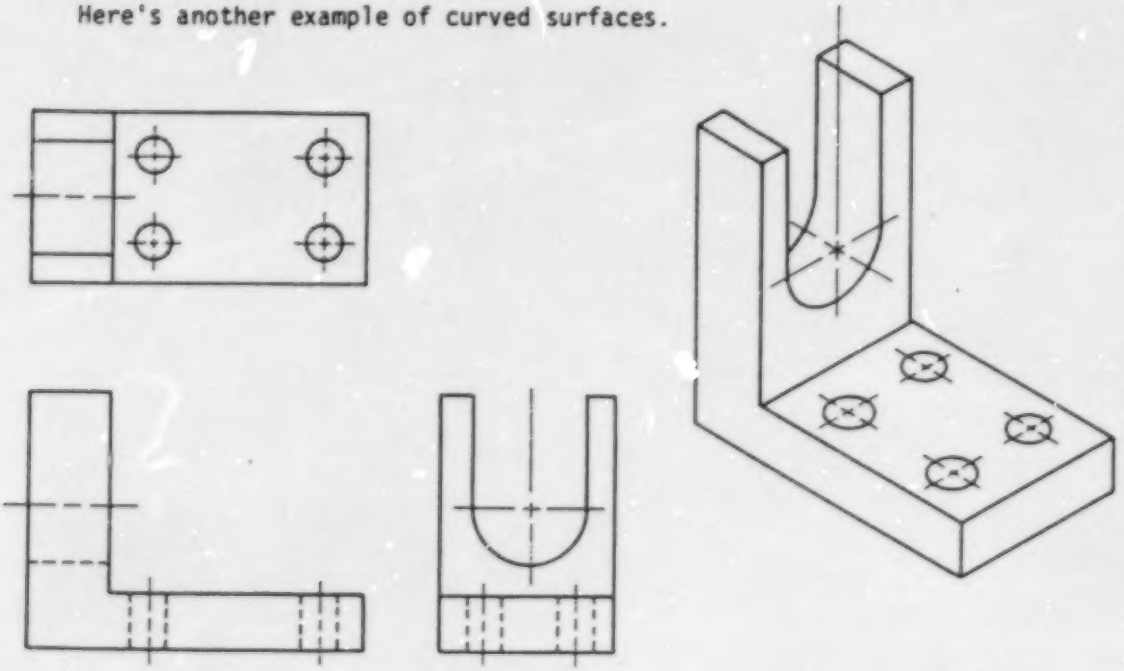


8. CURVED SURFACES

Curved surfaces are perhaps tricky to "see" until you remember that the curve is shown only in one view. You must put the curve in the other views yourself, through visualization.



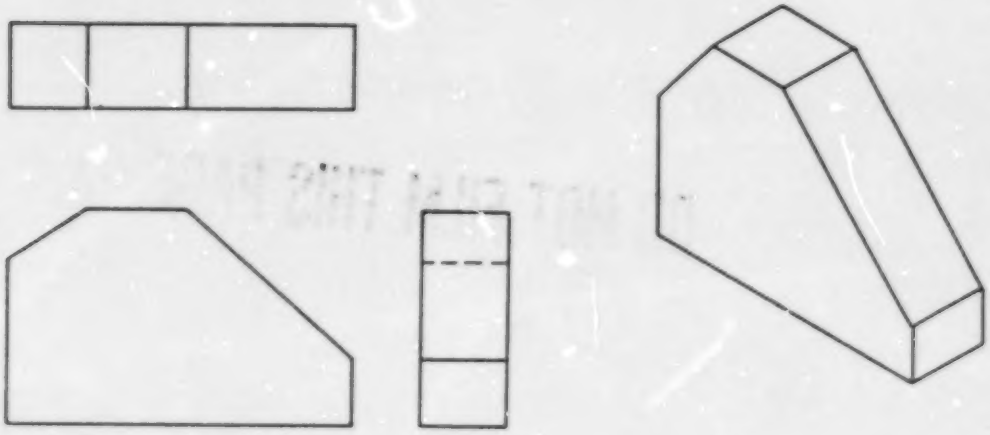
Here's another example of curved surfaces.



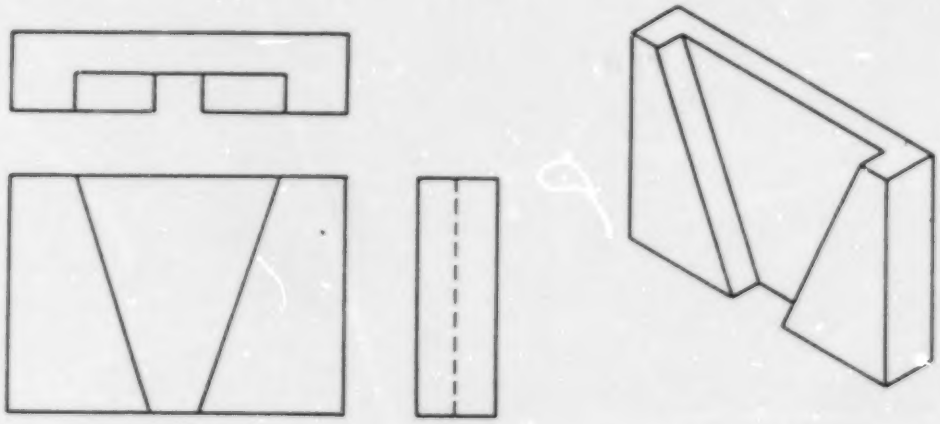
9. INCLINED SURFACES

Inclined surfaces are those which are at an angle, or slanted. In other words, they are surfaces which are neither horizontal nor vertical. In viewing orthographic drawings you need to be alert to angles and inclined surfaces, for they are often found on prints you will be reading later.

Notice the hidden line in the right side view created when the inclined surface joins the vertical end surface of this object.

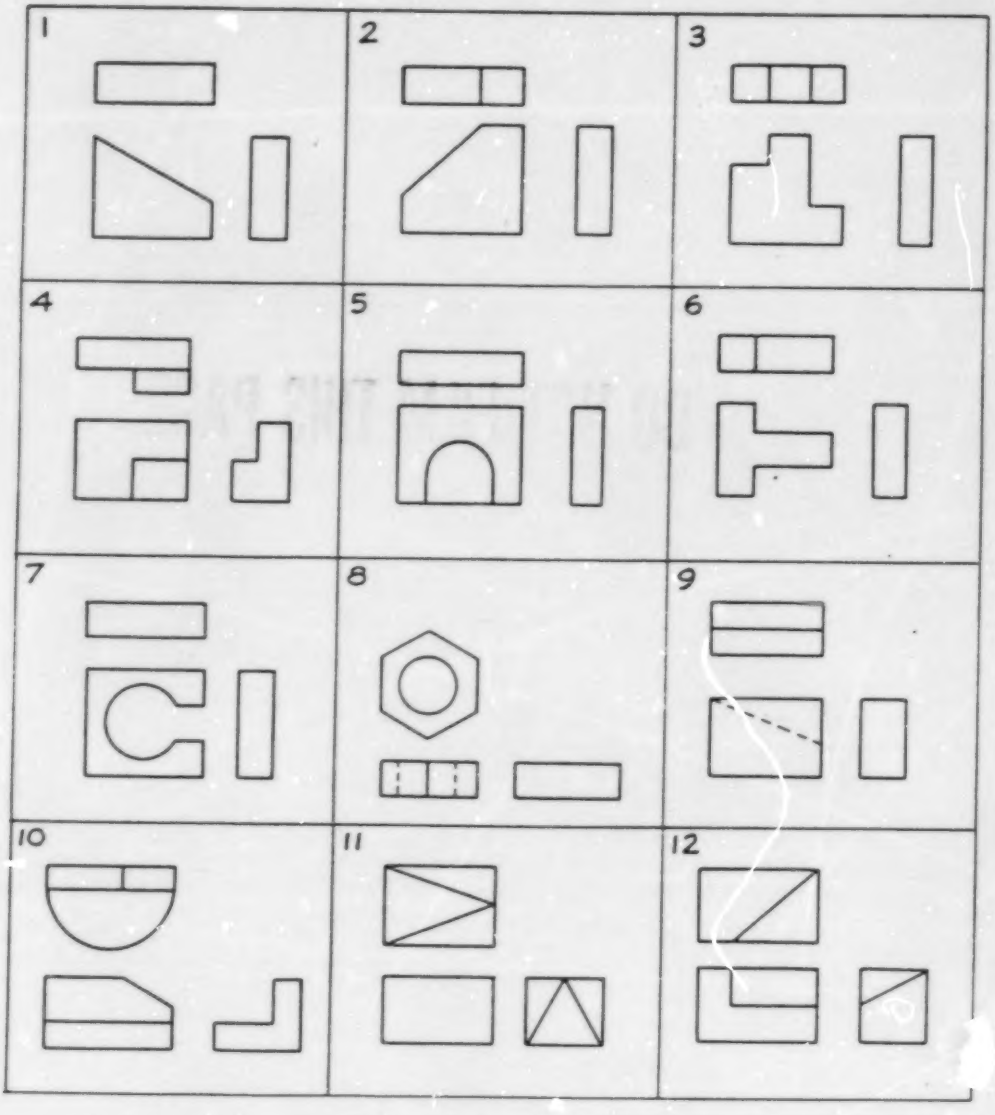
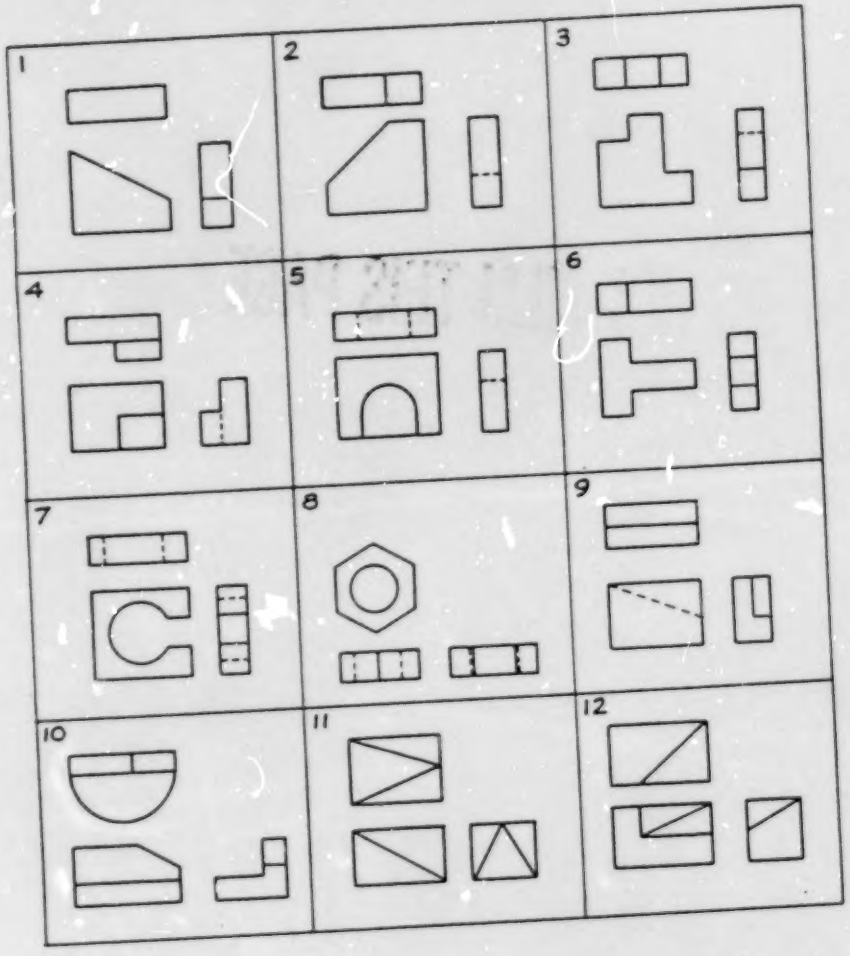


Here is an object with two inclined surfaces.



Self Assessment

Directions: With a pencil, draw the lines needed to complete the view.
One view in each problem is incomplete. Grade your test.
If you have 9 or more right go on to the next section.
If less than 9, erase your answers and repeat this module.



Answers to self test: